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A SONIC BOOM.

No person has pushed the limits of man and technology like Chuck Yeager. The year was 1947. Nobody knew if a fixed-wing airplane could break the speed of sound. More curiously, whether a human could survive the tremendous force of that kind of speed. Yeager was already a legend among WWII fighter pilots when he took off in the X-1 that day. Not only did he reach Mach 1 and create the first man-made sonic boom, he did it again fifty years later in an F-15 fighter. His résumé of military and civilian accomplishments is comprehensive enough to consume chapters in aviation history books. If one person defines what it is to be a man among men, he is Chuck Yeager.

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Road Trip

Driving is not an activity usually associated with the National Air and Space Museum, unless, of course, you are talking about driving on Mars. Since January 2004, the Mars Exploration Rovers—*Spirit* and *Opportunity*—have been doing just that, and on some days, the driver is a scientist from NASM's Center for Earth and Planetary Studies.

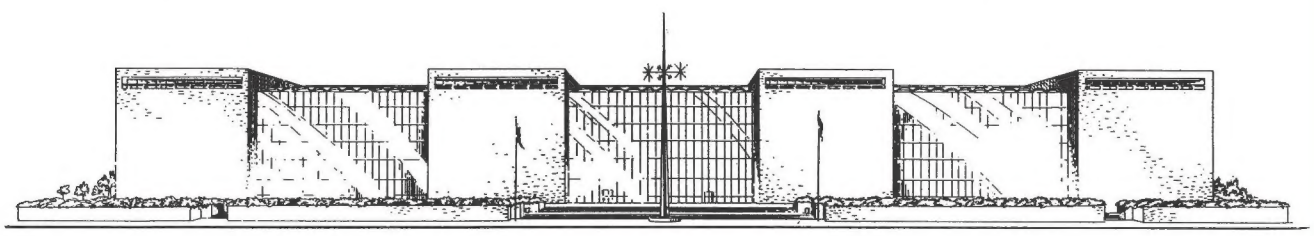
John Grant is a member of the rovers' Science Team and one of the Science Operations Chairs who guide day-to-day decisions about what the rovers will do and where they will go. His involvement in the mission includes co-chairing the group responsible for recommending landing sites for the rovers as well as participating in an initial phase of operations at the Jet Propulsion Laboratory in Pasadena, California (see "Next Stop, Gusev Crater," Dec. 2003/Jan. 2004). From January through April 2004, the period in which the rovers were expected to survive, operations were conducted on Mars time, which required conforming to a Mars "sol"—about 40 minutes longer than a day on Earth. The team had to start every day 40 minutes later, ultimately cycling completely through an Earth day about once every month or so. Combine that with the fact that the rovers are operating on opposite sides of Mars and are more than 12 hours apart in time and you have a recipe for serious jet lag. Although scientists got scheduling help from watches that ran on Mars time, the wear and tear of living away from home and keeping bizarre hours began taking a serious toll.

As it became clear that the rovers would significantly outlast their original "90-sol warranty," the prospect of continuing such a grueling schedule for an extended period became more daunting. Some relief arrived as the team became more efficient at planning rover activities and the process was streamlined enough to permit the members to move off of Mars time and work a fairly normal daytime shift. Operations were still being conducted at JPL, though, so many team members had to spend more time away from home. As the mission continued to return spectacular scientific results, lawns went un-mowed and gardens got weedy.

During late summer last year, however, all of that changed. Using the Internet, a phone line, and a secure computer that enables team members at multiple sites to plan rover observations and view data returned from Mars, work can now be carried out from an office right here at NASM. For about 10 days a month, Grant is assigned to one of the two rovers and remotely leads science planning activities. He is not alone, as sometimes planning involves people covering three continents and more than 10 time zones. Working with engineers at JPL, plans are made to drive up the Columbia Hills at Gusev Crater or to head south across the Meridiani Plains. Discoveries continue to be made at every step along the way, and with no end of the mission in sight, this road trip may continue for a long, long time.

You can follow the adventures of *Spirit* and *Opportunity*—and John Grant—on the Mars Rover Web site: *http://marsrovers.jpl.nasa.gov/home/*

—J.R. Dailey is the director of the National Air and Space Museum.



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*Eagle Eyes are patented, officially recognized NASA Spinoff technology and are on display at NASA's Houston Space Visitors Center.

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—Dr. Lyda D. Tymiak

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LETTERS

Nike: Notes From the Underground

I was raised in East Hanover, New Jersey, about 25 miles from Manhattan. In the early 1950s the Army built a Nike base just down the road in a cornfield about 100 yards off River Road, armed first with Nike Ajax and later Nike Hercules missiles ("Ring of Fire," June/July 2005). It was maybe 400 feet from our back door to the base fence (and we weren't the closest house), and there was a thick stand of woods between our house and the base, but when they snapped on the floodlights for some night exercise, every room in our house was lit up. We would all jump out of our chairs, hearts racing.

The radar control unit and its radomes were visible on the next ridge east, in Livingston. I recall vividly as a small boy watching a B-47 come screaming over the house at an altitude of a couple of hundred feet as it participated in some kind of war game, I think during one of the nationwide civil defense drills. Normally the airspace over the bases was restricted.

The base usually had something to catch your attention: men and vehicles going back and forth, missiles on the launch rails, warhead containers piled up. I remember a friend and I leaning against the fence one afternoon after school, watching a group of men working on a missile, when an officer spotted us and said something. A guard with a carbine ran over and said, "Boys, I know they're fun to look at, but you have to move on."

During the Cuban missile crisis, the place looked deserted, nobody and nothing above ground, and you could walk along the fence with nobody to say boo to you.

After the base closed, some of the younger boys liked to sneak onto the property and climb down into the underground areas. They said it was real spooky because of the dark, meandering workspaces, though they'd find the occasional souvenir. The base itself is gone now, turned into a condo development in the mid-1990s.

Bob Fiesser
Highlands Ranch, Colorado

I was stationed at White Sands Proving Grounds in New Mexico in 1955 and 1956, and by then, much of the Nike testing there had been completed, but many of my friends had been at the base during the testing, and they had interesting stories.

One of the most vivid was about the annual demonstrations of Nike capabilities for visiting Congressional committee members. In normal testing of the missile, base personnel simply fired at a point in space rather than an actual aircraft. However, that would not be meaningful for these committee demonstrations. I think it was at a 1953 or 1954 demo that they decided to shoot down a radio-controlled B-17.

The plane was launched from Holloman Air Force Base and, while it was flying around, out of sight, waiting for its radio-control circuits to stabilize, somehow control was lost and the B-17 crashed. A second plane was launched, but during its stabilization period a ham operator in Mexico inadvertently got on the same frequency as was used by some of the plane's control circuitry, and that B-17 also went down.

By then, the Nike project officer was getting pretty agitated, what with the Congressmen sitting out on sunny bleachers waiting for the fireworks to begin. He called for yet a third plane and told the base personnel to not wait for stabilization—just get it to the target area. The plane was still climbing when it got to the area and the Nike was sent after it. Nike controllers, watching their guidance radar, saw the missile was going to miss and pushed the self-destruct button. The Congressmen were quite impressed because they saw the burst from the Nike and an almost simultaneous explosion right about where the waist guns were located on the B-17. The plane broke in two. The story went that the demonstration succeeded because base personnel had planted explosives around the waist of the B-17, and the detonators were on the same frequency as the self-destructive circuitry of the Nike.

Ed Ver Hoef
Boonsboro, Maryland

We Need Our Space

I have subscribed for years, and I read every issue cover to cover, but the June/July issue, which included "Confessions of a Spaceship Pilot," "Robo Repairmen," and "Leroy's Launch," is the first one in which I've felt that the "Space" of *Air & Space* wasn't short-changed. Keep up the great coverage of both private and public spaceflight; many of your readers look to these articles first!

Charles Vane
Albuquerque, New Mexico

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We remember the New Year's Day Messerschmitt attack on the 365th Fighter Group in Metz ("Cold Front," June/July 2005). Our 95th Infantry Division liberated Metz in November 1944. The 365th mounted a splendid defense in shooting down so many of those planes; however, on the same day, two of the Bf 109s that got away attacked

COURTESY JOSEPH JANUSZKIEWICZ

Not fast enough: This Bf 109 escaped shootdown at Metz, only to be downed northeast of that German town.

our 95th Division position in the Saarlautern area, just northeast of Metz. One was shot down by our Tony Vittiglio. Enclosed is a photograph of that downed plane [above].

—Joseph Januszkiewicz
State College, Pennsylvania

Wernher Von Braun: Nazi?

In his review of *Dr. Space: The Life of Wernher von Braun* (Reviews & Previews, June/July 2005), Daniel Ford states: "Von Braun was not just a Nazi, he was also an SS officer and head of a factory that employed slave labor." Von Braun was never in military service or an SS officer. He also never headed the Mittelwerk factory, which used slave labor to make V-2 missiles. Mittelwerk's director was SS officer Hans Kammler.

Jiri Blazek
St. Augustin, Germany

Daniel Ford replies: According to the Web site www.nationmaster.com/encyclopedia/Wernher-von-Braun, *von Braun joined the Nazi party on May 1, 1937, and was an officer in the SS from May 1940 until the end of the war. In von Braun's own words: "in Spring 1940, one SS-Standartenführer [SS Colonel] Mueller…looked me up in my office at Peenemünde and told me that Reichsführer SS Himmler had sent him with the order to urge me to join the SS. I called immediately on my military superior…Major-General Dr. Dornberger. He informed me that…if I wanted to continue our mutual work, I had no alternative but to join." Von Braun reached the rank of Sturmbannführer (SS Major) in June 1943.*

Confessions of a Riveter

In 1974, I worked at Grumman as an assembler/riveter for the F-14 Tomcat. We worked from a kit bag that held detailed parts for attachment to the aircraft, but unlike O.H. Billmann and his co-workers ("Tear Down This Wall," Flights & Fancy, June/July 2005), we could not simply toss the damaged parts. At the time, the Shah ruled Iran, and every fifth aircraft was destined for that country. I was therefore instructed by a fellow worker (not management) that if I found a damaged part, I was to go to the next Iranian aircraft kit bag and swap the part, thus insuring that the part that was "whole" went to the U.S. Navy.

Matt Phillips
Northport, New York

When Cats Fly

Back in 1964 to 1966, when I was a pilot with the 59th Fighter Interceptor Squadron at Goose Bay, Labrador, one of the pilots was rotating back to Wright-Patterson Air Force Base in Ohio, and he decided to take his cat home in a T-33 Shooting Star ("Operation Provide Feline," Above & Beyond, June/July 2005). The pressurization in the "T-Bird" was such that at 35,000 feet you were lucky to get 25,000 cabin altitude. As a result, the cat, who was not in a cage, would start to nod. The pilot took his mask off, stuffed the cat's nose in it for a few whiffs, then put his mask back on. After a few times, the cat learned that when the mask came off, he needed to put his nose in it.

Howard Kidwell
Austin, Texas

Much Obliged

I'm not a pilot, I've never worked in the aerospace industry, and I've never served in the military. I've always been burdened with the sad knowledge that I'd almost certainly never be able to contribute anything to your fine magazine.

However, I am a Southerner. So when I read "The People and Planes of Creve Coeur" (June/July 2005), I knew my moment had come. In the contraction of "you all," the apostrophe goes between the "y" and the "a," not between the "a" and the "l," as you have it in Bo Mabry's quote on page 57.

If this helps, y'all are mighty welcome.

Scott R. Brooks
Atlanta, Georgia

Corrections

June/July 2005 "Cold Front," p. 72: The top photograph was taken by Charles R. Queen (now a colonel retired from the U.S. Air Force Reserve), and the bottom photo shows Christmas 1944, not 1943.

Reviews & Previews, *The Smell of Kerosene: A Test Pilot's Odyssey*: The James Michener novel *The Bridges at Toko-ri* highlighted the McDonnell F2H Banshee, but the movie version featured the Grumman F9F Panther.

Moments & Milestones: The metric equivalent of 62 miles is 100 kilometers, not 100,000.

Apr./May 2005 Reviews & Previews: The correct URL for the NASA World Wind program is as follows: *http://worldwind.arc.nasa.gov.*

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"What risks he took! What innovations he made!"

PHOTO: ERIC LONG

"Every time I'm in Washington I make sure I visit the Hughes Racer and then attempt to discover something new off in some corner of the Museum. I am never disappointed."

— AEROSPACE ENGINEER ED SACHTLEBEN stands before the Hughes H-1 Racer in the Museum's Golden Age of Flight Gallery. Designed by Howard Hughes and Dick Palmer, Hughes smashed the world speed record and transcontinental speed record with the H-1 in the 1930s.

For years, billionaire Howard Hughes' aircraft company was on the cutting edge of aviation. With a new engineering degree, Ed Sachtleben knew Hughes Aircraft was where he wanted to be. That began a 34-year career of designing satellite control systems — and a lifetime of admiration for Mr. Hughes and his engineers.

Ed Sachtleben knows the National Air and Space Museum shares his respect for aviation and space history. He's proud to have included the Museum in his estate, and is now a member of the *Smithsonian Legacy Society*.

Find out how you can include the National Air and Space Museum in your estate plans. Fill out and return the reply form below, or call 888-419-7584 Toll Free. You may also e-mail legacy@si.edu. Help honor the legacy of innovation!

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A&S 9-05

The National Park Service's Bomber

BRETT SEYMOUR/NPS

If you sink it, they will come: The National Park Service figures that divers from all over will be drawn to the B-29 at the bottom of Nevada's Lake Mead.

In 2001, a group of divers, using side-scan sonar, homed in on a Boeing B-29 Superfortress that had sunk to the bottom of Nevada's Lake Mead 53 years earlier. Because Lake Mead is a National Recreation Area, the airplane is the responsibility of the National Park Service, and in March 2003 and May 2005, underwater archeologists with the NPS's Submerged Resources Center in Santa Fe, New Mexico, surveyed and mapped the wreckage. The airplane, which rests at 170 feet in the Overton arm of the lake, is in excellent condition, because the darkness prevents marine growth and fresh water does not corrode aluminum as badly as saltwater does.

Wearing insulated drysuits and carrying 200 pounds of equipment each, the divers installed floats and anchored safety cables in preparation for opening the site to recreational divers later this year. "The Lake Mead B-29 is special not only because it's one of very few left," says NPS historian Bob Chenoweth, "but it's also a direct link to the space race and the missile race of the cold war."

On July 21, 1948, the bomber, modified as an atmospheric laboratory, swung over Lake Mead. The crew of five included pilot Captain Robert Madison, a 26-year-old with 163 combat hours in the Pacific theater of World War II, and John Simeroth, a scientist with the National Bureau of Standards. Simeroth sat in the navigator's seat, tending a top-secret package called the Suntracker, designed to steer missiles by the position of the sun. The cold war was beginning, and the U.S. military wanted missiles that couldn't be jammed from the ground.

On its final run of the day, the bomber skimmed low over the mirror-flat surface. Without warning, the airplane struck the water at 230 mph. Three of the four engines were torn off, the fourth caught fire, and the 70-ton aircraft skipped like a stone. The pilot struggled to regain altitude, but the bomber plunged back into the water. Four of the crew scrambled out and pulled the last man, a sergeant in the rear gunner's compartment, to safety minutes before the craft sank. That afternoon, rescuers spotted life rafts and picked up the crew.

Incredibly, the sergeant's broken arm was the only injury, but blame was spread far and wide. The crew said Simeroth had instructed them to fly "as low as possible," while Simeroth later said Madison had been hotdogging. Sunlight reflecting off the water or an incorrectly set altimeter may also have caused the pilot to misjudge his altitude. (Madison was killed eight months later at the controls of a North American B-25 Mitchell bomber that crashed in

HEADS UP

COURTESY KANSAS COSMOSPHERE AND SPACE CENTER

Mollett Early Spaceflight Gallery
Kansas Cosmosphere and Space Center
1100 North Plum
Hutchison, KS 67501
(620) 662-2305
www.cosmo.org

Reach out and touch a rocket. (And yes, you are *in Kansas.)*

Visitors to the Cosmosphere's newest gallery can stand in a representation of Cape Canaveral's Titan rocket pit and flame bucket, which channeled Gemini-Titan engine exhaust away from Launch Complex 19's gantries and rocket erector (above), hear mission control chatter and the countdown to Mercury and Gemini launches, climb the gantry next to the engines of a 100-foot Titan, and peer through the Blockhouse 5/6 periscope at films of actual launches—the same images NASA teams saw in the early 1960s. Cosmosphere facilities also include the Hall of Space Museum, the Justice Planetarium, Dr. Goddard's Lab, and the Carey IMAX theater.

Louisiana's Lake Pontchartrain in fog.)

Even though diving on the aircraft requires specialized gear and training, the Park Service predicts that the B-29 will become a popular scuba destination. Local dive shops are betting that a historic wreck within two hours of McCarran International Airport in Las Vegas will draw divers from around the country. In the meantime, the team of divers that found the airplane is suing for salvage rights. Since it is government property on public land, however, their chances of success are considered slim.

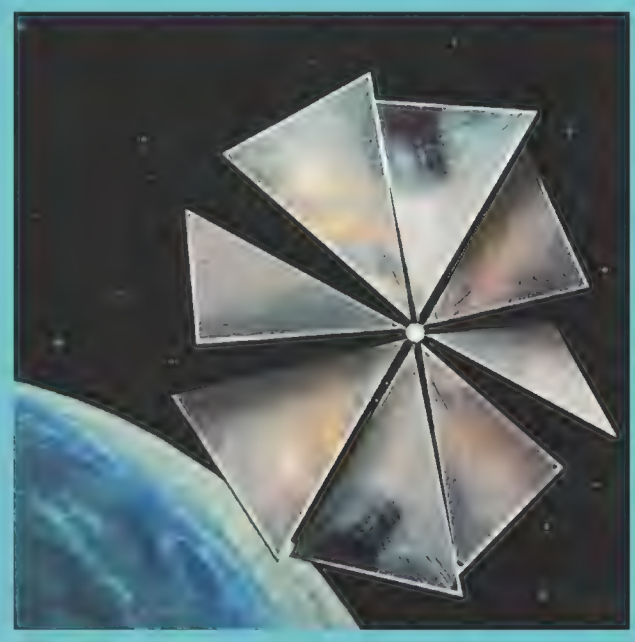
"It's just amazing down there," says Submerged Resources Center archeologist Dave Conlin as he emerges from a dive. "The water is murky and green, and then there's this silver plane in the darkness. It's almost like a spaceship."

—Julian Smith

UPDATE

Jinxed?

The Planetary Society's second attempt to place a solar sail into Earth orbit failed when the Volna booster's first stage misfired shortly after launch from a submarine in the Barents Sea on June 21 ("Slow but Steady," Soundings, Feb./Mar. 2005). In a previous attempt in 2001, the Cosmos 1 solar sail did not separate from the booster's third stage. The Planetary Society had hoped to make the first controlled flight of a solar sail, which is propelled by only the faint pressure of photons on its eight reflective triangular blades. Such vehicles are predicted to eventually achieve speeds five times as great as those achieved by a chemical-powered rocket.



PLANETARY SOCIETY AND COSMOS STUDIO

Will Cosmos 1 get a third chance?

The First Officer and the Fifth Grade

Southwest Airlines is one of many airlines whose pilots participate in mentoring programs for schoolkids. Southwest's program, called Adopt-a-Pilot, was launched in Washington, D.C., in September 1997, and the company estimates that the program has by now reached more than 80,000 children. But Southwest First Officer Michael "Bo" Miller's only concern one midday last April at the National Air and Space Museum was with 27 energetic kids and his efforts to ensure that none of them got lost. "It's hard to keep 'em together," he remarked as students from Westside Elementary in Baltimore, Maryland, toured the Museum in rambunctious fifth grade style. The Westside class is the first group in Southwest's Adopt-a-Pilot program to be mentored by both an airline pilot and a Congressman—U.S. Representative Elijah Cummings of Maryland—who are African Americans. The tour was part of a four-week program of education in all grade school subjects as well as in aviation.

Miller, 50, joined Southwest in 2004 after 20 years in the Air Force and some time at other airlines; he calls Southwest "my goal the whole time. I'm back to an airplane I really enjoy: the [Boeing] 737." This was his first mentoring stint with Southwest, though he'd been in similar programs at US Airways and the Organization of Black Airline Pilots.

At the class graduation ceremony—and farewell to "pilot Bo"—held in the Observation Gallery at Baltimore-Washington International Airport, the students were more serious and subdued. Wearing white mortarboards, they listened intently as Miller told of his own upbringing in difficult circumstances and how one teacher took an interest in him and showed him a career path to the U.S. Air Force.

"Pilot Bo" rallies his students at an Adopt-A-Pilot graduation.

AIR & SPACE/SMITHSONIAN

Joanne Martin, co-founder of the National Great Blacks in Wax Museum, and Vernon Simms, a representative of Congressman Cummings, both drove home the point that the keys to success are found in the classroom. Two artifacts from the wax museum—likenesses of astronaut Guion Bluford and Tuskegee Airman Chappie James—graced the gallery entrance.

A Southwest staffer provided a boom box for the playing of "Pomp and Circumstance" as the Westside students filed on stage to receive their certificates of graduation. They presented gifts to Miller and others, and at the end of the ceremony, they tossed their caps in the air and cheered—a scene reminiscent of Miller's own graduation day at the Air Force Academy in Colorado.

"My love for flying developed later in life," Miller said during a quiet moment. "I took an orientation ride in a jet and it blew me away. I decided that's what I wanted to do: be a pilot. Several people along the way encouraged me, so participating in Adopt-a-Pilot is my way of honoring them. If I can get one person to step outside whatever limited horizons they may see at the moment and look beyond their present circumstances, it will have been worth the effort." On this day, 27 fifth graders got the message.

—George C. Larson

NASA's Odor Meters

When something is rotten in the state of NASA, you can rest assured that George Aldrich will nose in. Aldrich is the space agency's senior odor evaluator, one of 25 unsung men and women who sniff materials before they're launched. Inhaling aromas on the ground is important before the object reaches orbit; a foul stench might distract

astronauts from their duties or even sicken them. During one Russian flight a horrendous stench forced cosmonauts to abort the mission. "They're in a confined space," Aldrich says. "Whatever they take with them they have to live with. There's no rolling down the window."

With his nose's approval, 787 different objects have rocketed into orbit, making him the Cal Ripken of space sniffers. Two others sampled 620 objects each before retiring. Third place goes to a now-active pair of nostrils that has savored 444 objects. "I'm setting the bar very high," Aldrich says.

Every time NASA needs a nasal analysis, its smellers sniff the object through a surgical mask. Each member ranks the object from 0 (fresh flowers) to 4 (rotting garbage). Anything funkier than an average of 2.4 won't make it through the space shuttle door.

Back in the early days of crewed spaceflight, NASA relied on mice to evaluate odors. "They heated the material and gently blew the gases over the mice and looked for adverse effects," he says. "Of course, they couldn't talk to tell you what it smelled like." In 1967, after 150 silent rodent evaluations, NASA recruited the first human sniffer. Seven years later, Aldrich, then a firefighter at White Sands Test Facility in New Mexico, asked to join the team, which works at White Sands. Aldrich aside, other team members may also be engineers, chemists, technicians, and secretaries. Three times a year each sniffer takes a test to ensure his or her sense of smell can distinguish among odors officially categorized as musky, minty, floral, ethereal, camphoraceous, pungent, and putrid.

During his 31 years on the job, Aldrich has sniffed a wide range of items. The best bouquet: Feminine hygiene products. The most malodorous: In 2002, astronaut Daniel Burbank powered up the space station, bringing a few Velcro straps to tie up floating objects. "The straps stunk so badly that he zipped up their storage bag and brought them back here for evaluation," Aldrich says. "The reaction was unanimous: We felt nauseated. One person described it as 'putrid.' If you cut an onion and smell your fingers five minutes later, and intensify it, that's what it smelled like." Aldrich adds that a rubber material, sandwiched between fabrics, and the adhesive were the guilty parties.

—Phil Scott

A Suit Fit for a Spy

Richard Lawyer, 008. The name and number aren't James Bond glam. But in his day, Lawyer may have been the next best thing to 007. If nothing else, he was better suited. His was sky-blue and custom-fitted, the essence of spacesuit fashion in 1965.

Lawyer was among the first of 14 armed forces officers recruited to serve aboard a U.S. military reconnaissance space station. With his husky physique, the 32-year-old Air Force major and test pilot was the ideal model for a multi-purpose pressure suit that would have been worn by astronauts flying to and from the Manned Orbiting Laboratory. "I wasn't the tallest or the biggest, but the combination of height and girth made me sort of the prime candidate," he says. "That's one of the reasons I got the task of being the pressure suit guinea pig."

Lawyer, now 72 and more interested in his grandkids than space history, hadn't thought much about this particular contribution to the cold war until recently, when a suit with "LAWYER" and "008" emblazoned on the left sleeve turned up at Florida's Cape Canaveral. A search for fire sprinklers at a stop on the Kennedy Space Center bus tour had taken investigators into a dark, dusty, unventilated, and abandoned storage room. Amid a hodgepodge of decomposing film, electrical equipment, and a used space shuttle landing gear was a box that caught the attention of NASA special agent Dann Oakland. "I opened the box out of curiosity because that's kind of what security people do," he says.

Oakland also found an identical suit with no name, just the number 007. Word spread across the Internet and to the suit's manufacturer, now called Hamilton Sundstrand and based in Windsor Locks, Connecticut. "People here were having a hoot," says company historian Ken Thomas. "Of course, back then, we didn't think of them as spy suits. It was going to be a manned orbiting laboratory with a big telescope that could be pointed, uh, basically anywhere."

What Lawyer wore was an MH-7 series training suit. They came in standard sizes and were adjustable to fit whoever put them on. During the development phase, Lawyer was in and out of his so much that it was easier to leave it cinched up and tag it with his name. Lawyer suspects 007 was for a smaller guy.

The flight model of the suit was designed to be simple and work for launches, reentries, and an occasional spacewalk. It also was compact and flexible because the two-seat Gemini capsules that would ferry spies to and from the station were cramped.

When the MOL was canceled in 1969, the Air Force offered the suit to NASA. Lawyer recalls that the agency wasn't interested: "They ho-hummed it to death." Now, according to Thomas, the

PEAK PERFORMANCE

Ain't No Mountain High Enough

Until recently, flying a helicopter in the rarified air of the Nepalese mountain peaks was a near-insurmountable challenge. But on May 14, Eurocopter test pilot Didier Delsalle landed on the summit of Mount Everest. He perched his Ecureuil Astar S350 B3 on the 29,035-foot peak, where the temperature was –30 degrees Fahrennheit, for nearly four minutes before returning to Lukla, the base camp at 9,400 feet from which he'd ascended. The flight set a world record for highest-altitude landing and takeoff.

COURTESY EUROCOPTER

A Eurocopter A-Star reaches Mount Everest's summit and lands in the record books.

MOL suits are creating a buzz among the designers of NASA's moon-Mars initiative. "NASA has been asking us questions about our MOL suits just recently," he says. "Nobody has been interested in them for years."

—Beth Dickey

Peacemaker Tug of War

The official military designation of the B-36 bomber—the cold war colossus that was the largest airplane ever to wear a U.S. Air Force star—was the Peacemaker. Ironically, because of a squabble between two Texas groups seeking stewardship over the last B-36 built, the *City of Fort Worth* is scheduled to leave its long-time home for a museum in Pima, Arizona.

But Fort Worth-based B-36 lovers are still hoping for a reprieve, thanks to an intense lobbying effort from local politicians and business leaders that comes on the heels of decades of apathy.

"People here are spoiled—they get an airshow every day from the military aircraft that fly around here," says retired Air Force general and airline pilot Bill Guy, president of the B-36 Peacemaker Museum. "But now that the Air Force is talking about taking the airplane away, the whole city has gotten behind it."

Unfortunately, Guy's group and its crosstown rival, the Aviation Heritage Association, can't agree on a plan—and neither has the resources—to build a facility to showcase the B-36, which has been resting in pieces outdoors since 2003. As a result, the National Museum of the U.S. Air Force, in Dayton, Ohio, recently decided that the Pima Air and Space Museum is the best place for the airplane, which was built and restored in Fort Worth and housed there since 1959.

Conceived in 1941 as a weapon to take off from American soil and bomb Nazi Germany, the B-36 wasn't finished until World War II was over. By the time it entered service in 1948, it was something of a white elephant, dwarfing the B-29 yet powered by six pusher propellers just as jets were becoming commonplace.

The airplane became the centerpiece of a bitter struggle between the Navy and the newly minted Air Force. Derided as a "lumbering cow" and a "billion-dollar blunder," the B-36 was replaced by the smaller jet-powered B-52 in 1959.

Still, the airplane had a special significance to Fort Worth. It was built there in a Consolidated Vultee (later Convair, later still General Dynamics, and now Lockheed Martin) plant, and two B-36 wings were stationed at Fort Worth's Carswell Air Force Base. In 1959, the 385th and last B-36 was flown from El Paso to Fort Worth.

The AHA was formed to preserve the airplane—dubbed the *City of Fort Worth* by the Air Force—and a restoration team, including many of its original builders, spent 44,000 hours refurbishing it in the early 1990s. But the AHA couldn't raise enough money to build a museum, and philosophical differences, including a controversial proposal to move the airplane out of Fort Worth to neighboring Dallas/Fort Worth Airport, prompted the formation of the B-36 Peacemaker Museum organization.

Unfortunately, the Peacemaker Museum "has no demonstrated record of performance as a museum and does not have the required resources or professional skills to qualify," according to Air Force museum spokesman Rob Bardua. After several Dallas/Fort Worth and other Texas museums declined to take on the substantial bulk and cost of the B-36—which has been in 19 pieces under tarps in a gravel lot after its storage hangar was reclaimed—the Air Force opted to send it to Pima, where it will be reassembled and put on display.

Guy remains optimistic that this decision can be reversed. "We've got a lot stirred up," he says. In fact, the city of Fort Worth has agreed to donate space for a museum—if enough money can be raised to build one. If not, Guy says, "it would be devastating."

—Preston Lerner

FRANK STEPHENSON

When City of Fort Worth *set a spell at Amon G. Carter Field in 1976, it was never at a want for company. Now that it's stored in pieces, it's not much of a draw.*

HEADS UP

COURTESY PLANES OF FAME

Air War: Korea

The Planes of Fame's North American F-86F Sabre will star in Air War Over Korea, one of the museum's monthly special events. A 10 a.m. seminar features veterans of the war in the air over Korea, and the F-86 will wrap up the day with a flight demonstration (weather permitting). The early-1950s conflict served as the stage for the debut of jet-versus-jet combat.

Sat., Aug. 6, 2005, 10 a.m.
Planes of Fame Air Museum
Chino Airport
7000 Merrill Ave., #17
Chino, CA 91710
(909) 597-3722
www.planesoffame.org

The Conductor

Americans know the names of many of their astronauts—John Glenn, Alan Shepard, Neil Armstrong—but not the names of the men who had to get the astronauts back home. For more than 30 years, Gene Kranz was one of these men. As the director of NASA's mission control in Houston, Texas, he worked on every major space program from Mercury to Apollo. His final assignment: overseeing the shuttle astronauts' repairs of the Hubble Space Telescope in 1993.

JSC/NASA

Flight director Gene Kranz was in charge when Apollo 16 launched on the afternoon of April 16, 1972.

On April 8, Kranz gave the annual John Glenn Lecture at the National Air and Space Museum on the Mall. Glenn, a retired astronaut and former U.S. senator, introduced Kranz as "a Mr. Cool if ever there was one." He reminded the audience of 400-plus people that Kranz had started working at NASA back in the days when the agency was sending up monkeys instead of men and establishing a global communication network with Morse Code and vacuum tubes. "I used to tease Alan Shepard [the first American in space] that he's the missing link between monkeys and men," Glenn quipped.

Glenn did not mention what Kranz confesses in his memoir, *Failure Is Not an Option—Mission Control From Mercury to Apollo 13 and Beyond*: that in November 1960, NASA hired the former U.S. Air Force fighter pilot sight unseen. When Kranz showed up at Langley Field in Virginia, he quickly learned that there was no job description because no one in the office had ever worked on a space project before. He floated for months without direction and "wondered whether I had come so far to be the saddest of all figures, an unnecessary man." Instead, Kranz went on to define mission control as a model of readiness, discipline, and organization.

After Glenn completed his introductory remarks, the two native Ohioans, dressed in conservative suits and standing with stiff military posture, embraced briefly on the stage. Kranz launched into his lecture without hesitation or pleasantries, moving at a steady clip, every line following the next like directions in a manual. Images of people working in NASA's mission control room flashed on a large screen behind him, but Kranz, confident in the organization of his slides, never once looked back to check on the sequence.

His steady baritone grew emotional when a photograph appeared of the three astronauts who died in the Apollo 1 fire—Roger Chaffee, Virgil "Gus" Grissom, and Ed White. "We listened to their screams when they died," he recalled. "We knew we were responsible for the first American space disaster. From then on I knew our mission control team had to be perfect."

This resolve proved instrumental again and again as Kranz helped crews in do-or-die situations. Of course Kranz' most famous save came during Apollo 13, when a routine stirring of oxygen and hydrogen stored in cryogenic tanks triggered a spark that led to an explosion, which blew apart a third of the spacecraft. The film *Apollo 13*, in which Tom Hanks plays mission commander Jim Lovell and Ed Harris plays Kranz, made "Houston, we have a problem" a national catchphrase.

"The movie was right on target," Kranz told the audience. "That's how it was. Though Ed Harris walks around cussing and kicking trash cans—you wouldn't do that in mission control. You'd do that in the hall."

Kranz' description of the problems he faced as mission control director for Apollo 13 brought to mind a conductor in front of an unruly orchestra. Kranz had to set the pace, anticipate problems, provide solutions for unforeseen disasters, and

DANE PENLAND

Home of the Intruder

A major player in the Vietnam War, the Grumman A-6 Intruder was designed as a long-range strike aircraft capable of flying low and fast to avoid detection by ground-based radar. Once behind enemy lines, the Intruder—with a crew of pilot and bombardier-navigator—tracked down and bombed small targets in all weather conditions.

The Intruder on display at the National Air and Space Museum's Steven F. Udvar-Hazy Center, an E model, entered service with the U.S. Navy on March 5, 1968, eventually flying day and night missions over Vietnam. In 1991, the aircraft flew missions during the first 72 hours of the Gulf War in Iraq. All told, the Museum's aircraft flew 7,500 hours and made 767 carrier landings.

Though the Navy retired its A-6Es in 1997, it still flies an A-6E variant, the EA-6B Prowler, which jams enemy air defenses.

group engineers and scientists into teams so he could get a steady stream of information on a host of issues, from a loss of power to carbon dioxide buildup. "It was a very lonely feeling," recalled Kranz. "We had to find a way to get out of the box we were in."

After the explosion, the astronauts lost two-thirds of their life support systems. They began to freeze and suffocate. Kranz' team came up with hand-typed 500-line fixes, which they read to the astronauts via radio. Chief among the challenges mission control faced was to correct the trajectory of the spaceship, the flight control system of which was severely damaged. At one point, one of the engineers told Kranz in exasperation, "We're going to miss the Earth."

In the middle of all this, the U.S. Navy called to inform Kranz that a typhoon had hit the planned landing area in the Pacific, forcing Kranz and his team to briefly consider changing the landing to the Indian Ocean. At this point in the lecture, the audience erupted in laughter. Kranz hadn't missed a beat or changed his tone, but the sheer volume of problems he described made the entire story improbable—except, of course, it did happen. For bringing the Apollo 13 astronauts home safely, Kranz and his team earned the Presidential Medal of Freedom, the United States' highest civilian honor.

Near the end of the lecture, Kranz displayed a slide showing him and his team crowded around desks strewn with coffee cups and ashtrays overflowing with cigarette butts. Their faces are flushed with exhaustion—and relief. Kranz' trademark vest (his wife Marta made one for him prior to each major mission) stands out white and clean. Finally, Kranz turned toward the screen to look at a picture of the Apollo 13 capsule, held aloft by three parachutes against a backdrop of clouds. "It was hard not to get emotional," he said. "We passed out 700 of the finest cigars. Sweetest smoke any of us had ever had."

—Mary Collins

VISITOR INFORMATION

Location The National Air and Space Museum is on the National Mall, along Independence Avenue SW, between 4th and 7th Streets, Washington, D.C. The Steven F. Udvar-Hazy Center is at 14390 Air and Space Museum Parkway, Chantilly, Virginia, near Washington-Dulles International Airport.

Hours The Museum on the Mall and the Udvar-Hazy Center are open from 10 a.m. to 5:30 p.m. every day except December 25.

Food The Museum on the Mall has the Wright Place Food Court, which offers selections from the lunch menus of McDonald's, Boston Market, and Donatos Pizzeria. The Udvar-Hazy Center offers food from Subway, located at the south end of the main hangar.

Shopping Both the Museum and the Udvar-Hazy Center shops offer a variety of souvenirs, books, DVDs, models, posters, clothing, and toys. A selection of these products can be purchased online at *SmithsonianStore.com*.

Donald D. Engen Tower The Udvar-Hazy Center has an observation tower from which visitors can watch air traffic arriving at and departing Washington-Dulles International Airport.

IMAX Theaters Learn how fighter pilots train for combat and view Earth from the open cargo bay of an orbiting space shuttle at the Museum's Lockheed Martin IMAX Theater and the Udvar-Hazy Center IMAX Theater, where large-format films are projected onto a screen five stories high. For information on tickets and showtimes, call (877) 932-4629.

NASM Express Shuttle Bus A round-trip shuttle runs between the Museum and the Udvar-Hazy Center from 9 a.m. to 5 p.m. Since the $12 round-trip shuttle tickets sell out quickly, visitors are encouraged to purchase them in advance at (202) 633-4629; toll-free: (877) 932-4629.

Curator's Choice
Occasionally a National Air and Space Museum curator gives a 15-minute talk about an artifact or subject of interest at the Steven F. Udvar-Hazy Center. Meet at the nose of the SR-71 Blackbird reconnaissance aircraft at noon. Aug. 4, "Saturn V Instrument Unit"; Aug. 18, "Hawker Hurricane: Britain's Other World War II Fighter"; Sept. 1, "Pitts S-1C Special: An Aerobatic Legend"; Sept. 15, "Amazing Space: Filling the McDonnell Space Hangar."

Fast, Cheap, and Out of Control

WAYNE SHIPP

Aviation archeology is one of my many hobbies. It's a way for me to literally touch history. That doesn't mean I spend all my time in the field. Frequently my most important work is done in the library. In the spring of 1997, I spent a lot of time collecting information for a database of airplane accidents that occurred in the vicinity of California's Edwards Air Force Base.

While researching in the periodicals section of the California State University library in Northridge, I stumbled across one aviation incident I had never heard of. The *Los Angeles Times* headline read, "208 Rockets Fired at Runaway Plane." A subhead continued, "Missiles Spray Southland Area in Effort to Halt Wild Drone." The story described terrified residents, property damage, and forest fires, all stemming from jet crews firing rockets at a wide area of northern Los Angeles County in an attempt to shoot down a runaway Navy drone airplane.

And I thought I knew every aviation mishap that had occurred since 1935.

The Grumman F6F Hellcat was one of the most successful fighters of World War II. Simple and rugged, it was built to absorb a great deal of punishment. Between 1942 and 1945, Grumman produced over 12,000 Hellcats. In 1946, a drone version designated F6F-5K participated in Operation Crossroads atomic weapons tests at Bikini atoll. Other Hellcat drones served as targets for missile tests at Naval Air Station Point Mugu in California. And, as I had discovered, one Hellcat drone ended its career in a blaze of unintended glory over the Mojave Desert.

On the morning of August 16, 1956, Navy personnel at Point Mugu prepared an F6F-5K for its mission. The aircraft had been painted red to make it easy to see. Red-and-yellow camera pods were mounted on the wingtips. Remote control systems were checked, and the Hellcat took off at 11:34 a.m., climbing out over the Pacific Ocean. As ground controllers attempted to maneuver the drone toward the target area, it became apparent that it was not responding to radio commands. They had a runaway.

Ahead of the unguided drone lay thousands of square miles of ocean into which it could crash. Instead, the old Hellcat made a graceful climbing turn to the southeast, toward Los Angeles. The Navy called for help.

At Oxnard Air Force Base, five miles north of Point Mugu, two F-89D Scorpion twin-jet interceptors of the 437th Fighter Interceptor Squadron were scrambled. The crews were ordered to shoot down the drone before it could do any damage.

Armed with wingtip-mounted rocket pods but no cannon, the Scorpion embodied the typical U.S. approach to countering the "Red Menace" of the cold war era. Each pod contained 52 Mighty Mouse 2.75-inch rockets. Salvo-launched, the Mighty Mouse did not require precision guidance capabilities. Large numbers of rockets would be fired into approaching Soviet bomber formations to overwhelm them. On this day, however, the rockets would be used against an altogether different red menace—one Hellcat, run amok.

At Oxnard Air Force Base, First Lieutenant Hans Einstein and his radar observer, First Lieutenant C.D. Murray, leapt into one F-89D, and First Lieutenants Richard Hurliman and Walter Hale climbed into a second. The interceptors roared south after their target.

Einstein and Hurliman caught up with

the Hellcat at 30,000 feet, northeast of Los Angeles. It first turned southwest, crossing over the city, then headed northwest. As the Hellcat circled over the quiet hamlet of Santa Paula, the interceptor crews waited impatiently. As soon as it passed over an unpopulated area, they would fire their rockets.

There were two methods of attack using the automatic fire control system, either from a wings-level attitude or while in a turn. Since the drone was turning almost continuously, they opted for the latter. But in repeated attempts, the rockets failed to fire during these maneuvers, a malfunction later traced to a design flaw.

The drone then turned northeast, passing over Fillmore and Frazier Park. It appeared to be heading toward the Antelope Valley's sparsely populated western end when suddenly, it again turned southeast toward Los Angeles. Einstein and Hurliman decided to abandon the automatic modes and fire manually.

The afternoon calm was shattered as Mighty Mouse rockets fell on the downtown section of Palmdale.

The interceptors made their first attack run as the Hellcat crossed the mountains near Castaic. Murray and Hale set their intervalometers to "ripple fire" the rockets in three salvos. The first crew lined up their target and fired, missing it completely. The second interceptor unleashed a salvo that passed just below the drone. Rockets blazed through the sky, then plunged earthward to spark brush fires seven miles north of Castaic. The fires destroyed 150 acres above the old Ridge Route, near Bouquet Canyon.

A second salvo from the two jets also missed the drone, raining rockets near the town of Newhall. One bounced across the ground, leaving a string of fires in its wake between the Oak of the Golden Dream Park and the Placerita Canyon oil field. The fires ignited several oil sumps and burned 100 acres of brush. The blazes raged out of control, threatening the nearby Bermite Powder Company explosives plant. The rockets also ignited a fire near Soledad Canyon, west of Mount Gleason, burning over 350 acres of heavy brush.

Meanwhile, the errant drone meandered north toward Palmdale. The Scorpion crews readjusted their intervalometers and fired their remaining rockets. Again, the obsolete, propeller-driven drone evaded the state-of-the-art jet interceptors. In all, the jet crews fired 208 rockets without scoring a single hit.

In Palmdale, the afternoon calm was shattered as Mighty Mouse rockets fell on the downtown section. Edna Carlson was at home with her six-year-old son William when a chunk of shrapnel burst through her front window, pierced a wall, and came to rest in a cupboard. Another fragment passed through J.R. Hingle's garage and home, nearly hitting Lilly Willingham as she sat on a couch. A Leona Valley teenager, Larry Kempton, was driving west on Palmdale Boulevard with his mother in the passenger seat when a rocket exploded on the street in front of him. Fragments blew out the left front tire and put holes in the radiator, hood, windshield, and even the firewall.

Miraculously, no one was injured. Explosive Ordnance Disposal teams from Edwards Air Force Base later recovered 13 duds around Palmdale. It took 500 firefighters two days to bring the various brushfires under control.

By the time the drone passed over Palmdale, its fuel had been spent and its engine sputtered and died. The red Hellcat descended in a loose spiral toward an unpopulated patch of desert eight miles east of Palmdale Airport. Just before impact, the drone sliced through three Southern California Edison power lines along an unpaved section of Avenue P. The camera pod on the airplane's right wingtip dug into the sand, and the Hellcat cartwheeled and disintegrated. There was no fire.

Having unearthed the details, I had to see if there were any traces remaining in the desert east of Palmdale.

On July 5, 1997, I searched for the crash site with a colleague, Tony Moore. Using information from the newspaper articles, we identified our search area. It was apparently near some dirt roads in an undeveloped section of the Antelope Valley. We followed a set of power lines until we came to a spot where the lines had obviously been spliced. Almost immediately, we spotted aircraft debris.

It soon became apparent that the material belonged to a relatively small, propeller-driven airplane. Some of the pieces had part numbers and Grumman inspection stamps. Fragments of exterior skin were painted red. There were numerous data plates from various components. We also found items from the cockpit and parts of the right camera pod. There was no doubt that we had found the crash site of the F6F-5K. Looking at the scattered wreckage, I wondered how the incident affected the careers of the various participants in the impromptu Battle of Palmdale.

—Peter W. Merlin

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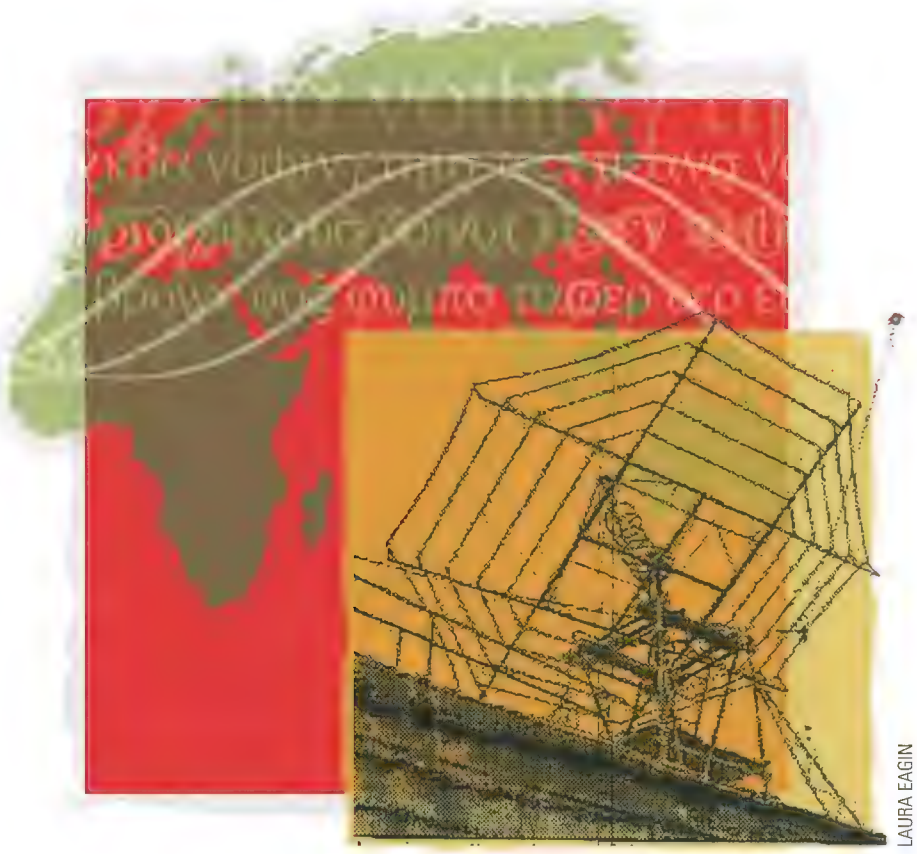
The Case of the Spurious Transmissions


LAURA EAGIN

The recording is of a woman's voice. She speaks in Russian, with what sounds like an edge of fear. "Listen! Listen!" she says. "Come in…Come in…Come in…Talk to me…Talk to me…I am hot! I am hot!…I can see a flame…" Was this a radio transmission from the first woman in space—a Soviet cosmonaut on a secret mission who died when her Vostok vehicle burned up on reentry? Or was it simply a hoax?

The transmission was supposedly intercepted on May 23, 1961, by Achille and Giovanni Battista Judica-Cordiglia, Italian brothers who eavesdropped on the Soviet space program from a post near Turin. Several years earlier they had purchased surplus U.S. Army equipment and begun to experiment with shortwave radio. After the 1957 launch of Sputnik, they listened in on Soviet spacecraft that passed over northern Italy. Eventually they established a rudimentary tracking station in the convalescent home where their father worked, in the village of San Maurizio Canavese.

Achille and Gian called their station Torre Bert (the name of the building was Villa Bertalazona; "torre" is Italian for "tower"). They built a 40-foot tracking antenna from junkyard parts. The hand-cranked device, which weighed 2,700 pounds, won a gold medal at a technology exposition in Turin. To calculate the Doppler shift in the transmissions they received—and thus the rate at which the objects were moving in relation to them—the brothers used an oscilloscope, comparing the wave patterns from transmissions with a fixed signal and then calculating the shift on graph paper. At one time the station had up to 20 workers and 21 antennas, including a mobile tracking unit. "Although much of the equipment is either homemade or dates back to World War II, it looks thoroughly efficient," said a 1965 article in *Reader's Digest*. "Inexpensive kitchen clocks on the wall give Greenwich Mean Time, local time in Moscow, Cape Kennedy and Turin. Operators wear white lab coats. The tracking console faithfully copies the one at Cape Kennedy—ingeniously modeled after photographs and scaled down to one fifth size."

The brothers were also interested in the U.S. space program. When John Glenn made the United States' first Earth-orbiting flight, on February 20, 1962, the Judica-Cordiglia brothers listened in on his transmissions to mission control. They had determined the correct frequency, they said, by determining the size of the antenna in photographs of the capsule.

Their most controversial interceptions were those purportedly from doomed cosmonauts. In November 1960—months before Yuri Gagarin became the first man in space—Achille and Gian claimed they intercepted a Morse code message that said, "SOS to the entire world," and later, "Conditions growing worse why don't you answer?" In February 1961 they taped a transmission of anguished breathing and a human heartbeat that an Italian heart surgeon said was from a dying man. That May they intercepted transmissions they said were from a crew of two men and the doomed female cosmonaut.

The Western press paid some attention—Italian papers and television covered them and the *Washington Post* and *New York Times* mentioned them briefly. In April 1965 the brothers also earned a denunciation from Radio Moscow, which labeled their claims "nonsense." Most Western space experts agree with the Soviets, citing a lack of evidence to back up the brothers' claims. In his 1981 book, *Red Star in Orbit*, James Oberg dismissed the brothers as "over-eager amateur radio listeners" who "singlehandedly wiped out an entire squadron of cosmonauts in the early 1960s." On his Web site, Swedish space analyst Sven Grahn concludes, "I think that the brothers did run a tracking station and picked up signals from various spacecraft. However, for some reason they thought that they needed sensational stories to maintain their image of a 'hot-shot' operation. Once they over-interpreted some receptions and made fantastic claims they were 'trapped' and had to continue to produce sensations."

The brothers shut down Torre Bert in 1965. Achille became a cardiologist—he still has Torre Bert's antenna in his garden. Gian took up the study of video and audio forensics. In 1969 he took the first color photographs of the Shroud of Turin as part of a scientific commission studying whether the cloth is the burial shroud of Jesus. The brothers have recently written a book, *The World Will Never Know About This*, maintaining that their stories are true. Giovanni Abrate, who with his brother created a Web site, *lostcosmonauts.com*, was a longtime friend of the two radio operators. "The U.S. vice consul spent many days and nights at their home," he says. "They had the close cooperation of the Americans and of the Italian intelligence agencies." According to Abrate, top Italian newsmen were sometimes present at Torre Bert when signals came in. "There was never any doubt that these transmissions were from space," he says.

—Tom Huntington

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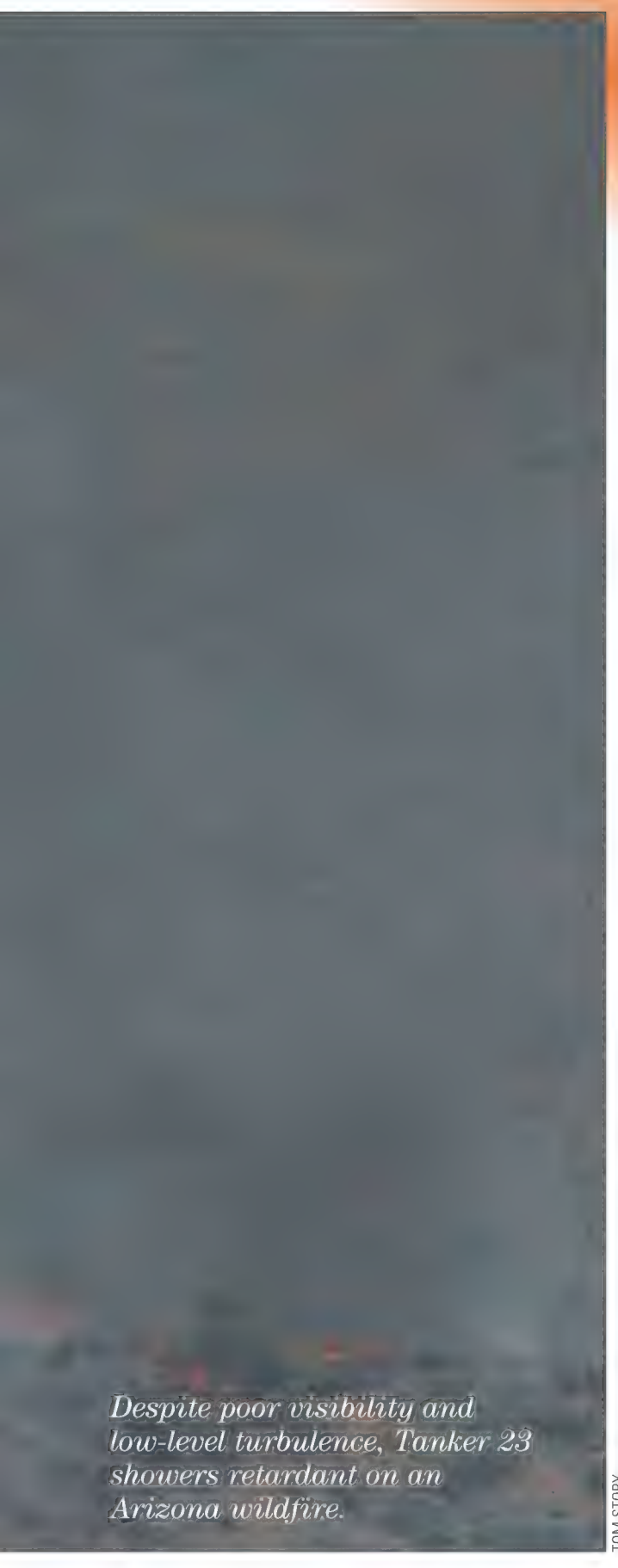
the RAINMAK

It's fire season. Are we ready?



Despite poor visibility and low-level turbulence, Tanker 23 showers retardant on an Arizona wildfire.

TOM STORY

ERS

BY DOUGLAS GANTENBEIN

In the rugged mountains outside Chico, California, workers swarmed over a sun-baked hillside, filling huge fabric bags with the shattered bits of a Lockheed P-3B: torn aluminum, blackened engines, broken propellers, and tangled wiring. Nearby, a small scuff showed where the airplane's tail compartment, used to hold sonar equipment when the craft flew for the Navy, had struck. In a few feet, the scuff grew into a long "V" of soil scraped bare. Beyond, charred stubs of manzanita bushes stuck out of the torn earth. And then, a massive pile of wreckage. The warm air smelled of jet fuel and the sage-like aroma of ceanothus shrubs. "It's like they just fell out of the sky," says Michael McCart, an insurance adjuster managing the crash recovery for the airplane's insurer, of the aircraft's three-man crew.

Five days earlier, at 6:38 p.m. on April 20, Tom Lynch, 41, Brian Bruns, 45, and Paul Cockrell, 52, had taken off in the P-3B from the Chico Municipal Airport. As chief pilot of Aero Union, Lynch was responsible for training the company's pilots in the demanding art of fighting fires from the air. Aero Union flies aircraft that have been modified to rain retardant on fast-moving blazes, and in preparation for the 2005 fire season, Lynch was evaluating the skills of Bruns and Cockrell. Bruns, who had flown P-3s for the U.S. Navy and still flew them for the Naval Reserve, was at the controls of the 39-year-old aircraft, its tanks filled with 2,550 gallons of water (retardant is not used for training missions). Bruns headed toward a mountain range north of the airport. Once there, the P-3B swooped low over hills and ravines so the crew could release water over the training area. The pilots had already made several practice runs that day, returning to the airport after each flight to refill the P-3B's tanks. On the final flight of the day, Bruns began maneuvering over the drop zone. A transponder on the aircraft stopped transmitting at 6:50 p.m., and a few minutes later, witnesses called 911 to report seeing a fireball and smoke rising from the mountains.

The Aero Union crash unnerved the small community that fights big fires from the air. Grief over the loss of the

DOUGLAS GANTENBEIN

Training turned fatal when a Lockheed P-3B tanker crashed in Chico, California, last April 20, killing all three pilots aboard.

pilots, who were known among the crews working for other aerial tanker operations, was mingled with worries that the tankers had simply grown too old and too hazardous to fly. Though the National Transportation Safety Board investigation may take more than a year to discover the accident's cause, one initial determination has brought a small amount of relief to aerial firefighters: All of the wreckage was found in one 400- by 100-foot footprint. Had the P-3B suffered a structural failure, the aircraft would have come apart in flight, leading to two debris fields on the ground. So despite its age, the tanker probably did not have a structural failure.

Such was the fate two tankers met three years ago. On June 17, 2002, as a 46-year-old Lockheed C-130A tanker was dropping retardant on a fire in Walker, California, its wings folded like a butterfly's and peeled off. The three crew members were killed in the ensuing crash. A month later, two more firefighters died when their 57-year-old Consolidated-Vultee P4Y-2 lost a wing—also during a retardant delivery, this one in Estes Park, Colorado. Both aircraft were owned and operat-

TOM STORY

Before heading to the fire line, a DC-7 visits a refueling base.

ed by Hawkins & Powers, a longtime aerial firefighting contractor based in Greybull, Wyoming.

The accidents threw the tanker community into turmoil. The U.S. Department of Agriculture's Forest Service grounded the remaining C-130As and P4Y-2s, then formed a commission to examine tanker safety. The commission's report, released December 2002, faulted the Forest Service for running aerial firefighting on the cheap, relying on aging aircraft, and not providing the oversight required to keep the flights safe.

A National Transportation Safety Board report, released in April 2004, was equally critical, citing a lack of maintenance standards and insufficient information about whether aircraft retired from the military were suited for firefighting. The NTSB investigations of the Walker and Estes Park accidents revealed that both tankers had fatigue cracks in the wings, flaws that visual inspections of the tankers' exteriors had not detected.

The NTSB report was the last straw for the Forest Service: On May 10, 2004, it canceled contracts for the heavy tanker fleet, taking 33 aircraft out of fire operations. By mid-summer, though, Aero Union's P-3 Orions had been cleared to fly after DynCorp Technical Services, an engineering consulting firm, determined that the operational life of an adequately maintained P-3 was 19,000 hours (substantially more than the number of hours each Aero Union P-3 had logged). DynCorp was able to quickly determine an operational life for the P-3 because the craft is still in service with the Navy and data was readily available. (Since the P2V Neptune is no longer employed by the U.S. military, figuring out the number of hours that the type could be safely flown would take longer.)

Devastated by the 2002 crashes and the loss of fire contracts, Hawkins & Powers abandoned the business of flying tankers. Neptune Aviation, based in Missoula, Montana, and Minden Aviation of Nevada scraped by with one P2V each (the airplanes were cleared to fly because they were wired to collect information on the stresses they endured in flight). And Butler Aviation, an Oregon company that flies three DC-7s, made up for the loss of federal contracts by securing work with the state of Oregon.

Within two years of the Walker and Estes Park crashes, the heavy tanker fleet had fallen from more than 40 to only a handful. That alarmed many in the fire business, who have seen summer fires grow increasingly aggressive in recent years. As it turned out, despite an early drought and the potential for a severe fire season, the summer of 2004 saw few fires, and, outside Alaska, the United States had one of the mildest fire seasons in years.

Still, the question remains: Are heavy tankers really necessary to fight fires? Certainly, other aircraft can do the job. Smaller, single-engine tankers, such as the Air Tractor AT-802F, which can carry 800 gallons of retardant, are becoming increasingly popular. And then there are helitankers, some of which can drop up to 2,000 gallons of retardant. Helicopters, however, are maintenance-intensive, and even more costly to operate than big aircraft; in many cases, they must work from refueling bases that need to be established near a fire. As for single-engine tankers, they lack the range of their multi-engine brethren, and their smaller payloads don't offer the impact of a 3,000-gallon dousing.

For speed of response and attacking a fire aggressively, nothing is as good as a heavy tanker. "They're great when you need a lot of retardant delivered quickly," says Jim Krugman, a longtime "incident commander," a role in which he oversees federal fire crews of 1,000 or more working some of the West's biggest fires. "For the job, they're crucial."

When the fleet of heavies numbered more than 40, fire managers often retained two or three aircraft to protect a particular area or assigned an aircraft to work a big fire for days. But with a smaller fleet, the focus is back on what multi-engine tankers do best: taking the first crack at a fire. With their speed, range, and payload, aircraft such as a P2V or P-3 can cross two or three states in one sortie and drop enough retardant to stop a newly detected fire in its tracks. "I've been fighting fires over 25 years, and I've seen [heavy tankers] retard fires many times," says Jim Ziobro, a fire aviation specialist with Oregon's Department of Forestry.

Despite the heavies' effectiveness, their troubled history had left them in limbo. But in May, a little certainty returned, with the Forest Service announcing that 25 heavy tankers would be brought back for the 2005 season. The reinstated fleet includes Aero Union's remaining seven P-3s, some of which battled blazes in Nevada in June. Tucson, Arizona-based Ardco has a federal contract for one of its three C-54s (the other two retained contracts with Oregon). And the Forest Service retained nine P2V Neptunes from Minden Aviation and Neptune after an engineering consulting firm finally pegged the service life of a P2V at 15,000 hours—far higher than what any of the current Neptunes have logged. Rounding out the fleet are eight Lockheed C-130s—fitted with removable modular tanks—

flown by Air National Guard units. "This is definitely good news," says Larry Brosnan, assistant director of aviation for the Forest Service. "We traditionally had as many as 40 air tankers, and when we terminated contracts on the fleet last year, we were left with eight. We got by, but last year was a relatively easy fire season. The addition of the P2Vs back to the fleet is very welcome."

It's clear, though, that in the history of aerial firefighting, a page has turned. It wasn't that long ago that a tanker base looked like a museum, with World War II-era airplanes scattered around the runway. Mark Timmons, the president of Neptune Aviation, recalls walking onto the airstrip at Alamogordo, New Mexico, a popular base for tankers, and feeling catapulted back in time. "I expected to see Howard Hughes walk out from under a wing," he says.

But Timmons' Neptunes are no spring chickens either. His office, attached to a spacious hangar at Missoula's airport, is lined with photographs of the company's P2Vs roaring low over burning forests. Inside a roomy hangar, two Lockheed Electras (the airliner on which the P-3 Orion is based) are midway through conversions to tankers. Rows of Wright Cyclone R-3350-24W radial engines sit in a corner, ready for installation in just a few hours. Outside, nine of the P2Vs, neatly painted silver and red, fill a parking area. On a Friday, when maintenance crews are off, it's quiet.

The P2V's military background translates well to firefighting. "The Navy did the same maneuvering to chase submarines that we do around a fire—making short turns at low level," says Christian Holm, Neptune's director of aviation safety. "It's a great platform—very stable on the approach." Holm, who joined Neptune in 1998 after a career in ground-based firefighting and flying drug interdiction missions, climbs up through the nosewheel hatch of a P2V and into the cockpit. The airplane was built in 1954, but its instruments and controls are new, making it look factory-fresh.

For tanker pilots, the season begins mid-spring with checkouts in aircraft, a review of fire tactics, and training

TOM STORY (2)

Arizona had a busy fire season in 1994: A Consolidated-Vultee P4Y-2 operated out of a base in Phoenix (right). Firefighters Rick Phebus, Greg Smith, and Rachel Longknife (left to right) got help from a P2V Neptune while battling a blaze near the Tonto National Forest.

LEFT AND OPPOSITE PAGE: TOM BAUER

Neptune mechanic Andy Lassila inspects a tanker's tail.

runs with loads of water. From May through October, most crew members are on the road: first in New Mexico, Arizona, and Nevada, then northward as states such as Montana and Idaho heat up and dry out. A typical day starts when the air crews report for duty at a reload base, an airfield set up to mix and load retardant. A duty day lasts 14 hours, a long time to cool one's heels on a sun-toasted, wind-swept airfield if there are no fires to fight. "You have to find a hobby or read to kill the time," says Bob West, a tanker pilot who joined Neptune Aviation last year after flying for many years with Hawkins & Powers. "That time can be more stressful than flying."

Most fires in the West are started by lightning. A big thunderstorm can ignite 15 to 20 fires, and during July and August, it's not unusual for 400 fires to break out in a single day. When that happens, air crews fly continuously during their shifts, stopping only to refuel and take on retardant, logging 20 or more flights in an aircraft that is noisy and hot (many tankers are not air-conditioned).

Because of the volatile nature of wildfires, each run poses different risks. Says West: "You can't concentrate on just one thing; if you get a fire fixation, you start looking at the fire and lose track of everything else. So you keep your scan going. First: Are you really sure you have a good idea of where they want you to drop? When that's satisfied, I make sure that I have a good exit. I want to know what the air is like: Are there downdrafts or rotor wash or updrafts once I cross over a ridge? Are there any snags [dead trees] in the area? They can stick above the live trees and are hard to see. Then, if it's a big fire, there will be a lead airplane to join up with. I want to know what that pilot's experience is, and whether the information he's giving me jibes with what I'm seeing."

West takes a breath: "You never commit yourself to a run until you've taken all that into consideration."

Tanker pilots drop retardant at speeds of around 140 mph, with the aircraft flying as low as 150 feet above the trees. The retardant tanks in the bellies of P2Vs contain six chambers, each with a door that is controlled by toggles in the cockpit. The pilot selects the number of chambers to open in one pass and whether to release the retardant in a dribble (better over light fuels such as brush or grass) or a heavy spray (to punch through treetops and hit the ground in front of a fire). Retardant, the bright pink stuff that makes for such dramatic television footage, isn't meant to extinguish a fire. Instead, it contains chemicals that interrupt combustion. The idea is to slow the fire so that ground crews have time to finish digging fire lines, strips of bare earth that deprive fires of the trees and brush that fuel them.

Crews try to avoid flying directly over the fire because a big blaze can throw a column of hot air into the troposphere, and no pilot wants to get caught in the updraft. Instead they come in from the sides, skimming the trees in front of the fire, then banking up and away. Summer temperatures add to heat from the fires to create terrific turbulence. And smoke cuts visibility, increasing the likelihood of the tankers colliding with the helicopters and spotter aircraft in the area.

Despite the harrowing conditions, most pilots stay in the business for years. For Holm, flying an aerial tanker is a matter of service to fellow firefighters. "I really want to do the best job I can for the guys on the ground," he says. "I know what it's like to be down there in 100-degree heat, climbing up hills with all your gear on your back." Pilot Bob West likes the freedom to work hard in the summer and take much of the winter off. But he also knows the hazards: He got started fighting fires at Hawkins & Powers back in the 1970s because one of the company's pilots had been killed.

Big guy, but will it fly? A 747 releases 20,000 gallons.

COURTESY EVERGREEN INTERNATIONAL AVIATION, INC.

Everyone in the industry agrees the fleet must be modernized. But how? In April, Department of Agriculture Undersecretary Mark Rey, who is in charge of the Forest Service, suggested that more P-3 Orions could be salvaged from the surplus-aircraft boneyard at Arizona's Davis-Monthan Air Force Base. But tanker operators aren't interested in repeating the old pattern of trying to squeeze life out of tired airplanes.

Other aircraft types have been proposed as new retardant tankers: Fairchild A-10 Thunderbolts, Ilyushin 76TD jet transports, and the Canadair CL-215, an amphibian that can alight on a lake, fill tanks with 1,400 gallons of water, then fly to a fire. But those proposals have all foundered on technical problems or contract hurdles. Evergreen Aviation, an air transport company based in McMinnville, Oregon, is testing a 747 that could drop more than

20,000 gallons of water or retardant on a fire. Early tests of the giant tanker have shown promise, and the 747 may be flying over fires in California this summer. Unlike the current heavy tankers, which rely on gravity to draw retardant out of the tanks, Evergreen's 747 has a pressurized application system that enables the tanker to release its load at a height of 800 feet above the fire.

Neptune Aviation is working with Canadian aircraft manufacturer Bombardier to fit a Q200, a twin-engine turboprop regional airliner, with a tank that could hold 1,800 gallons. Aero Union, meanwhile, believes the Navy's S-3 Viking, a twin-engine turbojet used as a tanker and an electronic countermeasures craft, has promise. The Navy plans to begin retiring a number of S-3s that are still relatively young (the first began flying in the 1970s).

Both projects require money. Timmons says that "tanking" a Q200 and running tests on a single aircraft could cost around $4 million. Aero Union would like to collaborate with the Forest Service in studying the S-3 Viking. Both companies hope the federal government chips in, but that money has not been forthcoming from the Forest Service or any other government agency. "We traditionally rely on commercial vendors to provide that [design and test work]," says the Forest Service's Larry Brosnan. "We don't have any plans right now to do any testing of commercial aircraft."

That hands-off attitude frustrates air tanker operators. A single airplane may pull in more than $1 million in revenue during a busy season, but without firefighting contracts, these aircraft have few uses. Says Hank Moore, who operates three DC-7 retardant tankers out of Oregon and has been in the business since 1960: "You just can't spend millions of dollars unless you know in advance there will be a profitable use for the airplane. And right now the Forest Service just hasn't been clear on what they want us to do."

The lack of urgency is due in part to the fact that multi-engine tankers don't dominate aerial firefighting as they did in the 1960s and 1970s. "Heavy tankers provide a very small portion of retardant delivery," says Brosnan. "It used to be about 20 percent, and that's when we had a lot of air tankers. Today, helicopters are pretty much the workhorse." Indeed, the vast majority of the nearly 800 firefighting aircraft on tap for this year's fire season are helos and small fixed-wing aircraft.

Terry Johnson flies his company's flagship aircraft, the P2V Neptune, one of 25 heavy tankers cleared to fly this fire season.

So the multi-engine tanker fleet continues to dwindle, but the big craft are not going to disappear completely; they can still do what helicopters and smaller airplanes cannot. "Back when there were more tankers, we really relied on them, and we're hoping that the aerial firefighting companies can start developing new aircraft soon," says Rod Nichols, a spokesperson for Oregon's Department of Forestry.

It took the 2002 accidents for the Forest Service and some heavy-tanker operators to start doing what should have been obvious: Ensure that the aircraft are well-maintained and safe to fly. But with efforts to genuinely modernize the big-tanker fleet moving slowly, if at all, one hopes another crash isn't needed to spur the process. "We'd be foolish to understate the value of these aircraft," says firecrew manager Krugman. "A new-generation aircraft is not going to be anything but a benefit—for the pilots and those on the ground." Until one comes along, though, keep your fingers crossed for rain.


Spaceman
FROM MOONWALKER TO SHUTTLE COMMANDER,
JOHN YOUNG DID IT ALL. BY GEOFFREY LITTLE

John Young begins one of his last full weeks at NASA by heading to the regular Monday morning "all pilots" meeting at Houston's Johnson Space Center. Wiry and fit at 74, a bit lower to the ground than he used to be, Young moves through the center with a determined gait. On duty, he usually wears a nondescript gray suit; off duty, he's at home in a big black Stetson, denim jacket, and jeans, clothes that harken back to his boyhood in the farm country of Orlando, Florida. It's December 2004, and the six-time astronaut, who has been to the moon twice, has announced he'll retire at the end of the month.

In the astronaut office's meeting room, it's all business. Most of the active-duty astronaut pilots are present, including Alvin Drew, 42, a former Air Force pilot who was born the same year Young joined NASA. The main topic today, as it has been for nearly two years, is the shuttle's return to flight after the loss of *Columbia* and its crew in February 2003. Young stands up to speak, and the room goes quiet—what Drew calls "the E.F. Hutton effect." "When he talks at a meeting, any side chatter just stops," Drew says. "He doesn't say anything unless it's important."

Drew recalls another such briefing, in the dark days right after *Columbia*. "The number-one job of any astronaut," he remembers Young saying, "is to keep any other astronaut from getting killed." Like other younger members of NASA's space corps, Drew looks up to Young as "the corporate knowledge.... He knows what mistakes we've made, what mistakes we've made twice, and he's there to keep us from making those mistakes a third time, or a fourth time."

One of Drew's first encounters with the veteran astronaut was in January 2000, when he was applying to NASA. Among the first things on the agenda was a briefing from John Young, "to give you a reality check." Young wasted no time, showing some numbers on an overhead projector to the group of 19 candidates. "You have a 1-in-258 chance of a catastrophic failure on any given shuttle mission," he told them. Drew wasn't sure whether that was good or bad. Then Young put up risk numbers for air combat, "things like fighters over the top of Hanoi." Drew was surprised by Young's next remark: "Flying one shuttle mission is as dangerous as any 60 combat missions you would fly."

Drew, a veteran of 90 helicopter combat missions in Panama and the first Iraq war, remembers thinking, "These were not generic missions where nobody's shooting at you, but real 'no kidding there's bullets flying'-type combat missions." Young's statistics didn't deter anyone in the class, he says, but it made them think.

Today in the December meeting, with the return to flight on everyone's mind, Young is going to make them think again.

"Who here thinks the culture at NASA has changed?"

After a slight pause, Young asks for a show of hands, looking around the room at the veteran and rookie astronauts. Not one hand goes up.

ALL PHOTOGRAPHS: JOHNSON SPACE CENTER/NASA

Waiting inside the Gemini 3 capsule on March 23, 1965, John Young (opposite) was about to embark on the first of six voyages into space—seven if you count Apollo 16's liftoff from the moon. Young's technical savvy and staying power won admiration from several generations of astronauts, including the crew of STS-114 (right).

Back from the moon in 1972, Young dove right into work on the space shuttle, while other Apollo vets left NASA.

He has asked the question because he is gravely concerned that NASA's management culture still allows fatal flaws. A few days later, in a set of rare interviews with the Associated Press and another with the *Houston Chronicle*, Young makes his point publicly by stating that the odds of a catastrophic failure on the shuttle now stand at 1 in 57, the number of flights to date divided by two fatal accidents.

When I catch up with him for an interview a month later, he elaborates. "We've proven 1 in 57, but who can say what it really is? I don't think anybody has a clue what will happen next, or what unusual thing will happen that we haven't thought about." I ask: Will the shuttle be able to keep flying? "Hope so," he says. "I think you gotta try. I mean, nobody ever guaranteed it was going to be risk free."

It's a perfect summary of NASA's essential dilemma: trying to make the inherently dangerous business of spaceflight as safe as possible. And it's vintage John Young: blunt and matter of fact. In a video tribute at Young's retirement ceremony at the National Air and Space Museum in December, the actor Tom Hanks said: "John Young is one of my heroes, a man who did what had to be done, regardless of the consequences." In the front row of the IMAX theater, Young couldn't help but grin. In the past he's grumbled to friends, good-naturedly, about the fact that Hanks' 1998 HBO miniseries, *From the Earth to the Moon*, skipped over his Apollo 16 mission entirely.

Young seems aware of where he stands in the astronaut pantheon: the hard-working professional, but never the star. He doesn't seek the media spotlight, and is at his best in the company of his scientific and engineering peers. If you're serious, he'll take you seriously. His fellow astronauts say he also can be very funny, in a droll, you-had-to-be-there kind of way. But his reserve is hard to penetrate, even for people who have worked with him closely. Michael Collins, Young's crewmate on Gemini 10, wrote in his memoir, *Carrying the Fire*, that of all the early astronauts, "John is the most uncommunicative (with Neil [Armstrong] a distant second)."

He is also, hands down, the most experienced. At the retirement tribute, Bob Crippen, Young's pilot on the shuttle's first flight, lauded him as "the astronaut's astronaut," not just for having flown six times but for his technical understanding of spaceflight. Brewster Shaw, Young's pilot on shuttle mission STS-9 and now chief operating officer of United Space Alliance, the company that operates the shuttle, told the audience of veteran astronauts that John Young had "the most intuitive engineering mind I've ever seen."

He had always been concerned with safety; even back in the Gemini days he was known for writing critical, well-reasoned memos that came to be known as John Young Safety-Grams. "That's what test pilots are for," he says. "They're supposed to look at stuff and see what's right and what's not right, and if it's not right, you gotta tell 'em."

Young built his first airplane model when he was six years old: "a high-wing airplane; I think it was a Waco," he says. As an undergrad at the Georgia Institute of Technology, where he was a Naval ROTC commander and aeronautical engineering major, he showed an early interest in rocketry, if not exactly space. In 1951, as a junior, he published an article in the Georgia Tech *Engineer* on the German V-2 rockets built by Wernher von Braun. "I didn't say very nice things about him, because, you know, using unguided rockets to hit civilian targets was not very nice," he says today. "I never dreamed that he'd [von Braun] come over here and build the Saturn V."

Initially, Young set his sights on a Navy flying career. But the Navy had other ideas, and assigned him after graduation to serve as a fire safety officer on the USS *Laws*, a destroyer that saw combat during the Korean War. Flight training had to wait until after the war. In 1959 he was selected for a coveted slot at Patuxent River Naval Air Station in Maryland, home to the Navy test pilot school. There he helped wring out what would be the Navy's first Mach 2 fighter jet, the McDonnell F4-H1 Phantom II.

In 1962, Young found out just how fast, and how high, a stripped-down Phantom could go. On a cold, clear February day, he took off from Brunswick Naval Air Station in Maine in an attempt to set a record for time to climb to 3,000 meters (just under 10,000 feet), as part of the Navy's Project High Jump. He did it in just under 35 seconds, and says his real time was actually faster, but the "statistics guys" adjusted it for 95 percent confidence. Two months later, Young set the 25,000-meter record, taking off from Pt. Mugu, northwest of Los Angeles, and zooming to 82,000 feet in just under four minutes. In his pressure suit, he could glimpse the dark edge of space before he coasted back to land in the Mojave Desert.

BOB BUTTON

Young (at the blackboard) had plenty of engineering smarts, but Gemini crewmate Michael Collins (below, right) called him the least communicative of the astronauts.

After the death of buddy Gus Grissom (left, during a break in Gemini training) in the 1967 Apollo 1 fire, Young's "Safety-Grams" took on new urgency.

Like many test pilots of his generation, Young also had his eye on a contest that was just getting under way. He applied to NASA, thinking it "looked like a good way to use what we'd been trained to do," and in 1962 got the call to join the New Nine, the group of astronauts chosen after the initial Mercury Seven. President Kennedy had just committed the nation to a lunar landing—or rather, Young says, "They said we'd try. Nobody knew we could go to the moon. They were talking about using hydrogen in the engine. The only thing I knew that burned hydrogen didn't work too good, and that was the *Hindenburg*."

Three years later, on March 23, 1965, Young and Mercury veteran Virgil "Gus" Grissom became the first two Americans launched together into space, on Gemini 3. Young was the first of the New Nine to fly.

He remembers his first look at the Earth from orbit. "I didn't realize it [would be] so beautiful. I could hardly take my eyes off it," he says. "I was so busy looking out the window I sort of neglected the trajectory data." During the crew's three revolutions around Earth, Young did look away enough to operate the first guidance computer in space, and he took the first clear hand-held photos of features on the ground.

After a rough reentry (during the parachute's descent, Young and Grissom were thrown forward so violently that Grissom's visor cracked), Young resolved to go right back into space. "I told Deke [Slayton, head of the astronaut office], 'Put me on the next mission you can.' And I guess he did the best he could." Young commanded Gemini 10 in July 1966, with Michael Collins on board as his copilot.

Gemini 10 was an ambitious mission that rehearsed several techniques needed for Apollo: rendezvous, docking, and, for Collins, a spacewalk. Young had to be careful not to blast his crewmate with exhaust from Gemini's maneuvering rockets while Collins was outside; he doesn't think such a risk would even be allowed today. And another complication arose. "I think the night before the mission, Reg Mitchell [a

For some, circling Earth in the space shuttle would have been a letdown after walking on the moon. But for Young, shown with STS-1 pilot Bob Crippen during a rehearsal (right) and walking to the pad on April 12, 1981, it was another test piloting job.

Gemini engineer] came in and told me, 'Oh yeah, and by the way, don't let the sunlight hit the top of Mike's ejection seat, 'cause the sun is so hot it will probably fire the ejection seat," Young says. "So then I not only had to fly formation [with the docking target]...and not squirt on Mike, but I had to keep the sun off the ejection seat."

After Gemini, Young set right to work on Apollo. In mid-January 1967, he went to see good friend Gus Grissom down at Cape Canaveral. Grissom showed him the inside of the command module, set up for his crew's full-dress systems test. Young remembers peering inside the craft at the wiring. "There were bundles as big as my arm that were going around sharp corners, and you know as soon as you fly, going around a sharp corner with a big wire, all you're going to do is chafe it and set if off," he says. "I asked him [Grissom] about it, and he said, 'I can't say anything about it. If I do, they'll fire me.' That's what he told me."

On January 27, 1967, Young was in California running checks on the next-to-fly Apollo capsule. He remembers seeing toxic glycol leaking on the floor. Just the day before, fellow astronaut Dave Scott had been in a spacesuit pressurized with oxygen and had gotten badly shocked. "He's very lucky he didn't get electrocuted, burnt to death," says Young. "Things weren't very good in those days."

The same afternoon, while Young was in California, Grissom, with Roger Chaffee and Ed White, perished on pad 34-A in Cape Canaveral, in what would always be referred to at NASA as simply The Fire. The bad wires had sparked a conflagration in the oxygen-soaked module.

NASA responded with a two-year, top-to-bottom redesign of the command and service modules. Young and other astronauts believe the changes saved their lives. He had always been concerned with engineering safety; even back in the Gemini days he was known for writing critical, well-reasoned memos that came to be known as John Young Safety-Grams. "That's what test pilots are for," he says. "They're supposed to look at stuff and see what's right and what's not right, and if it's not right, you gotta tell 'em." In 1964, Bob Gilruth, the first director of the Manned Spacecraft Center in Houston, told his assistant, George Abbey (later himself director of the Johnson Space Center), to sort the mail to decide what was important. Abbey remembers Gilruth saying to him, "The one thing I want to see if it comes through is a memo from John Young. If he writes a memo, and he's got a concern, then I've got a concern. He's the best engineer I've got working for me."

Young was assigned to the May 1969 Apollo 10 mission, the second to orbit the moon. It was a full dress rehearsal for the first landing, with Young flying solo around the moon in the command module for eight hours while Tom Stafford and Gene Cernan took the lunar module down to 50,000 feet above the surface. Orbiting the moon alone, Young was particularly struck by the number of craters on the far side. "Most of the backside of the moon is just highland impacts," he says. The idea of bombardment—huge meteors smashing and shaping the lunar surface for eons—would stay with him.

After returning to Earth, Young went through rocky personal times, as did many of the astronauts during the high-pressure years of Apollo. He was divorced from his wife of 10 years, the mother of his two children, and later married Susy Feldman, who worked for a NASA contractor in St. Louis.

In those days, no one at NASA knew the odds of success for the moon landings. As Young was training to command his own 1972 landing mission, his new wife told him something disturbing. She had learned about a formal risk analysis that put the chance of survival on future moon missions as low as 20 percent. Young claims it didn't affect his thinking, but it was upsetting to his wife, and apparently to NASA. "George Low never let anybody see those numbers," Young says today. Low was the space agency's deputy di-

The space shuttle's inaugural flight was the only time in history that a launch system made its first spaceflight with people on board. During launch, Bob Crippen's heart rate went up to 130, but Young's wouldn't break 90. "I want mine to go faster," he told Crippen, "but it won't. I'm too old."

rector at the time. "I really believe that's why the big guys wanted to knock off [Apollo] 18, 19, and 20 [the later missions that were canceled in 1970]. Even if they'd had the money, they didn't see the benefits of lunar surface exploration, in terms of real scientific benefits, but they thought they were going to lose some people. You know, they might have."

Young's Apollo 16 crew did not face anything as grave as the explosion that nearly scuttled Apollo 13, but the moon landing proved to be Young's most difficult mission yet. He almost didn't land at all. A problem with the command and service modules' thrust control system in lunar orbit delayed the landing for hours while mission control assessed the risk. Finally NASA gave a "go," and six hours behind schedule, Young and Charlie Duke separated from Ken Mattingly in the command module and descended to the surface. Even after the anxious delay, Young's heart rate at touchdown barely broke 90 beats per minute. By contrast, most Apollo commanders' hearts were racing as they landed; Neil Armstrong's hit 150.

Climbing down the ladder to the lunar surface, Young talked like an explorer: "There you are: mysterious and unknown Descartes. Highland plains. Apollo 16 is going to change your image." After four spaceflights, John Young was finally where he wanted to be—roaming the moon. He and Duke walked and drove more than 16 miles of the lunar surface. All the time, scientists on the ground kept asking if they were seeing the volcanic rocks, or basalts, that all the pre-mission science predicted would be at Descartes. Young insisted that what he was collecting was breccia, rocks made by meteor impact. When geologists later examined them, it turned out he was right. "See, you can even train a fighter pilot to be a geologist," he joked. Lee Silver, a California Institute of Technology geologist who helped train the Apollo astronauts, was impressed: "[Young] was really more dedicated to getting maximum return from his missions probably than anybody else," he says today. "That's a difficult thing to say, because there were so many dedicated people. But if I had to pick one man to lead an expedition where he had both to master the medium and at the same time keep his eyes on the scientific goals, I would pick John Young."

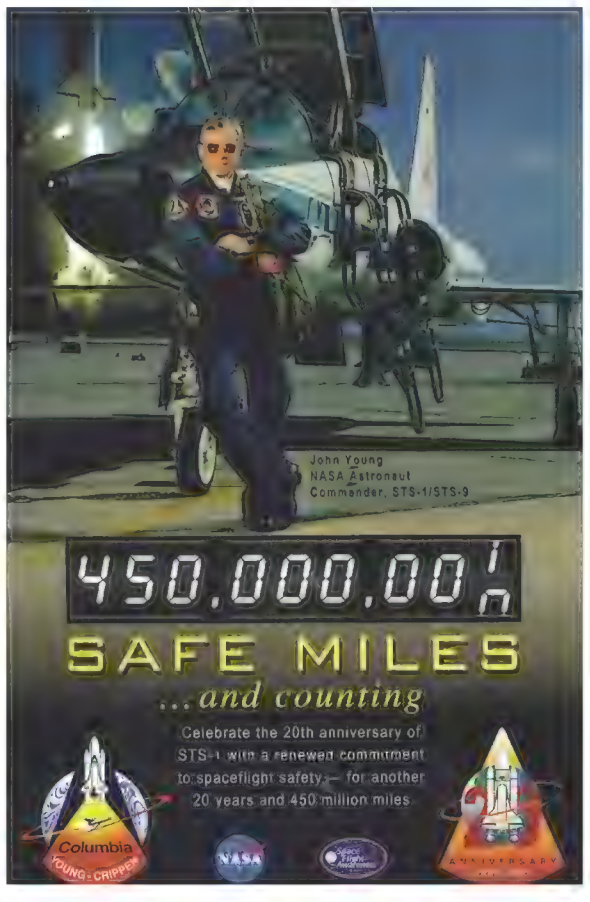
Before leaving the moon, Young and Duke got word from the ground that Congress had approved funding for the Space Transportation System—the space shuttle. On his return, Young immediately went to work helping to design and test the new vehicle. He went right back into the simulators, while most of his Apollo colleagues left NASA. Gene Cernan, who made the last landing during Apollo 17, told Marcia Dunn of the Associated Press that after Apollo, he "couldn't go back in the dungeons" of simulator training. He marveled at his colleague's staying power, joking that someday "100 million years from now, they'll dig up [the Johnson Space Center] and find John Young at his desk."

By 1977, just five years after the last lunar landing, Young was the sole Apollo astronaut left at NASA. When it came time to pick a commander for the shuttle's first spaceflight, George Abbey had no hesitation in choosing Young, who also had a say in the matter. He'd been promoted in 1974 to chief of the astronaut office. Once again, though, his wife came forward with concerns. "She was very upset with the whole business. She used to work on the Minuteman down on the Cape, and they kept blowing up," he says, referring to the missile's temperamental solid-fuel motors. "Then she found out we were going to have two solid rocket motors on the space shuttle, and she was really upset."

Young's pilot on the first flight would be a space rookie, Bob Crippen. A seemingly endless series of delays due to problems with everything from the main engines to the heat tiles made Crippen joke that by the time they eventually flew, the crew wouldn't be Young and Crippen, it would be "Old and Crippled."

Finally launch day arrived: April 12, 1981. It was the only time in history that a launch system made its first spaceflight with people on board. As the STS-1 astronauts sat on the pad, Crippen's heart rate went up to 120, then, during launch, to 130, but Young's wouldn't break 90. "I want mine to go faster," he told Crippen, "but it won't. I'm too old." Young was 50.

The two-day flight had its bothersome moments: ground control deluged them with too many messages



By 2001, when this NASA safety poster came out, Young had become a kind of conscience for the agency. But his frequent safety warnings had also lost some of their impact.

Impressions of a moon battered by impacts stayed with the astronaut-explorer; he now lectures about the threat of killer asteroids.

via the noisy teleprinter; it was cold in the cabin, about 50 degrees (though Young said during his crew debriefing, "I was too proud to say anything"); the toilet didn't function properly; and Young faced blinding sun glare, and had to use his hand as a visor much of the time. Young sloughs it all off now. "Yeah, I wasn't worried about all that stuff," he says. "It was incidental." After the landing, addressing a crowd at the desert landing strip, he was uncharacteristically poetic about NASA's new vehicle: "We're really not too far—the human race isn't—from going to the stars."

In 1983, the 53-year-old Young, who now needed half-moon glasses to read the fine print of onboard instructions, commanded STS-9, the first flight of the Spacelab science laboratory. In the shuttle's payload bay was a pressurized 20-ton module that carried 73 experiments run by seven people working 12-hour shifts. For Young, STS-9 was still very much a test flight, and it had more than its share of technical problems. During reentry, two of *Columbia*'s computers went out within five minutes of each other. The attitude control system suffered a failure, and one of the hydraulic power units caught fire at 40,000 feet and burned all the way to landing. At the time, recalls Young, "We didn't know it was on fire. We had no idea. Fact is we landed on Thursday and found out about the fire on Saturday—so that's the kind of fire to have."

Young had now made six spaceflights, more than any other astronaut or cosmonaut. But he wanted one more. As chief of the astronaut office, he penciled himself in for another historic mission: the deployment of the Hubble Space Telescope.

Then *Challenger* exploded. It was a cold day, January 28, 1986. Just three weeks earlier, Young had written one of his famous memos, arguing that the shuttle should go back to landing in California instead of Florida, even though the change would add ground processing time. He was concerned that the fickle Florida weather might lead to brake failure. The shuttle program managers rejected the idea.

The day of the *Challenger* launch, Young was flying the weather plane, circling the pad, keeping an eye out for storms, wind, and temperature changes. From his aerial perspective, he saw it all happen. "We were holding at 20,000 feet and watching them lift off, and I got a picture of the whole thing blow—coming apart," he says.

"Very sad. Very needless, because Leon Grabe, my old buddy, had written [about problems with the booster rockets' joints] back in 1977. Nobody was listening. Just the same damn thing with the frigging...." He stops himself, his mind now on a more recent tragedy. "They had wing leading edge damage of some kind that was pretty bad, and nobody paid any attention to it [before] *Columbia*."

On March 4, 1986, just weeks after NASA's first fatal accident in space, Young wrote a scorching internal memo. Blunt as ever, Young enumerated safety problems dating back at least two years before the *Challenger* accident. "If we do not consider Flight Safety

Young has stated that the odds of a catastrophe on the shuttle now stand at 1 in 57, the number of flights to date divided by two fatal accidents. But, he says, "Who can say what it really is? I don't think anybody has a clue what will happen next...that we haven't thought about."

First all the time at all levels of NASA, this machinery and this program will NOT make it," he wrote. "If the management system is not big enough to STOP the Space Shuttle Program whenever necessary to make Flight Safety corrections, it will NOT survive and neither will our three Space Shuttles or their flight crews."

At the time, NASA forbade astronauts to speak with the media. Someone leaked the memo to a reporter at the *Houston Post*. Angered, NASA managers moved Young up and out of the astronaut office, to the position of the center's Associate Director, Technical, and bumped him from flight status. Even though the commission that investigated *Challenger* later backed Young's findings, he was still grounded. By that time, George Low, Bob Gilruth, and other allies in top management were gone. The Hubble mission finally flew, without John Young, in 1990.

"Young fought a lot of losing battles," says one close colleague, who thinks the Safety-Grams eventually lost their impact. Even his *Columbia* crewmate, Bob Crippen, joked at Young's retirement tribute that all NASA managers (including himself) have file cabinets overflowing with Young memos.

Though without a mission, he maintained his flight readiness status in T-38 jets and in simulators. "I did think I'd probably be reassigned to a flight, but it just didn't happen," Young says. In recent years, he started joking that flying another mission would be too dangerous: "Susy would kill me." Last December, NASA's longest serving astronaut, whom one friend calls "the archetypal extraterrestrial," finally hung it up—being an astronaut, that is. He is still philosophically extraterrestrial, convinced that space is humanity's ultimate escape system.

"There's a 1-in-455 chance of a civilization-ending event in the next century," he says, ever ready with the statistics. "We can't avoid catastrophe; we've got to plan for it." Young has come to believe that a triple threat of disasters—asteroids, super volcanoes, and ourselves—could end civilization, and soon. The 2004 tsunami in Southeast Asia, he thinks, was nothing compared to what's ahead. And he believes the technologies NASA is developing to live on the moon—inflatable structures, rapid-growth-cycle wheat, alternative energy sources—could be our salvation.

In a remarkable series of memos to NASA's upper management in his last years at the agency, Young laid out his case for why a "single planet species" can't survive. In one 2001 note, he made a case for returning to the moon. He signed it "John Young, Ex-Lunar Field Geologist."

He still attends planetary science conferences, and plans to write scientific articles now that he has the time. After discussing geology and related topics in our phone interview, I say, "You sound like a scientist." He goes silent. Then, sounding slightly offended, Young replies, "I'm not a scientist. I'm an engineer. I'm just a guy who wants to get things done and get on with it."

I've come to think of John Young as a kind of test pilot for the planet, looking for ways to make the vehicle a little safer, or at least make sure we have a backup system if things go wrong. He wants us all—astronauts and Earth's future generations—to have a nominal flight.

But as an old test pilot, he's not going to admit taking himself too seriously, not to outsiders. When I ask why he's still at NASA three weeks after his retirement, Young quips, "I'm just using the phone." He plans on "hanging around" the agency for a while, and recently signed on as a consultant to NASA Headquarters.

Before signing off our interview, I ask if he has anything else he'd like to say to *Air & Space* readers. "Keep flying," he answers. "It's fun. Sure beats work." That's John Young, keeping it loose, no matter what.

Citizen of Earth: With STS-9 crewmate Ulf Merbold (right) in 1983 and again at a European space conference last year.

PLANES, TRAI

In South Africa, vintage train tours by Rovos Rail are the last word in luxury. A pair of classic Convair 440s has added a bonus to the journey.

NS, & WATERFALLS

by Sam Goldberg | Photographs by Baron Wolman

Herman van Niewehuizen had lost his cool.

That much was clear when he stomped off the train he managed for South Africa's Rovos Rail and climbed into our Jeep. He punched a number on his cell phone and motioned the driver to turn down the radio and get on the road to Pietersburg's airport. As he waited for his call to go through, van Niewehuizen turned to photographer Baron Wolman and me and hissed: "The Americans! They didn't listen! Rohan was very clear. Everybody else pre-packed. One hundred fifty-five kilograms of luggage!"

On the other end of the line, Rohan Vos picked up. Vos, the owner of Rovos Rail, had warned his passengers about their luggage. Two days earlier, he'd gathered them in Rovos' Pretoria rail station to explain the itinerary and the rules of the luxury rail-and-air tour on which they were about to embark. Of the passengers, little was expected. Beyond the jacket and tie he asked gentlemen to wear for evening meals, his only request was that when the train had covered the 200 miles to Pietersburg, where passengers would transfer to a 1950s-era airliner for the final leg to Victoria Falls, they were to have whittled their carry-on luggage down to just 15 kilograms (33 pounds) each. The remainder of their belongings would follow on another airplane.

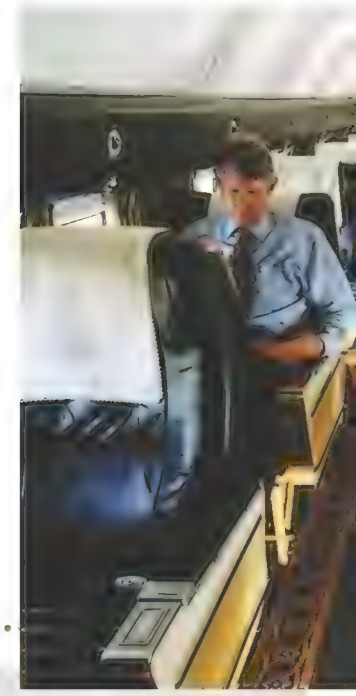
The Americans—a trio of lawyers from New York City and a small child—had played dumb and refused to split up their luggage. Now they would need to shed a total of 95 kilograms of carry-on, and that would delay their bus ride to the airport and possibly the flight itself. Van Niewehuizen was pre-coronary. He cursed into the phone, mixing Afrikaans with accented English. Though we couldn't hear it, the message from Vos' end of the line seemed clear: *Herman, calm down.* The aircraft were fogged in at their base in Lanseria, 150 miles south. The New Yorkers would have time to repack.

It was January, just past the peak of Africa's summer tourist season. At Rovos' invitation, Wolman and I had traveled to South Africa to experience service aboard the company's Consolidated Vultee 440s. They are among the last of the 1950s-era, twin-radial-engine airliners flying. Rovos uses its two 440s mostly on trips to Victoria Falls, the thundering, mile-wide cascade on the Zambezi River along the Zambia-Zimbabwe border, but they also team up with the company's Douglas DC-3 on air safaris around southern Africa.

When addressing the passengers from behind a conductor's stand inside the rail station, Vos looked every bit like a lanky, distinguished Willy Wonka. His enormous hands flared with each sentence as he welcomed travelers into the world he created for his own amusement: more than 60 train carriages, five antique steam locomotives, three classic airliners, and a 56-acre rail station site, which also hosts a transportation museum and a soccer pitch. The company dates back to 1986, when he purchased and refurbished a few train carriages he hoped to convert to a rolling vacation home. Rail fees ended up being too daunting for the trips he wanted to make with his family, so the railways suggested he cover costs by selling tickets to tourists.

Rovos' Convair 440s are rarities: 1950s airliners still airworthy and transporting paying passengers.

OPPOSITE: ROVOS RAIL PHOTO LIBRARY



Rohan Vos (right, seated) wanted a classic pressurized, recip-powered aircraft to complement his rolling stock. Then he added splendor: leather, linen, and fine cuisine.

Fifty years ago, Metroliners plied short-haul routes around the world (right, a Swissair 440). The nostalgia rush one gets from the Convairs (above) comes at a cost Rovos accepts: The airliners have limited capacity.

The idea stuck. In 1989, Rovos launched its first journey, a round trip between Pretoria and Kruger National Park. The same year, Vos sold off the auto parts business that had made him wealthy to devote himself fully to his rail enterprise. In 2001, he added the airplanes.

Like all Rovos routes, the Pretoria-Victoria Falls trip appeals to those who want the romance of luxury rail travel through a distant and exotic land. The slow journey through Gauteng province offers gourmet meals and unlimited wine, big beds, and claw-foot bathtubs. A couple of hours aboard a luxurious airliner, on the other hand, seems less meaningful to most passengers. In fact, the majority hadn't given the flight to Victoria Falls a moment's thought; all they cared about was that the flight gave them the opportunity to photograph one of the world's seven natural wonders.

The 440 was Convair's response to the superior but pricier four-engine, turboprop-powered Vickers Viscount. It was the company's second iteration of the 240 Convair-Liner airframe, a design that debuted in 1945 as the world's first pressurized, twin-engine transport. In 1951, the 340, with an extended fuselage and wings and increased fuel and seating capacities, hit the skies.

By comparison, the 1954 upgrade from the 340 to the 440 was mostly a cosmetic one. In fact, the 440 had been designated the 340B until the company decided a snappy name—Metroliner—and an aggressive marketing campaign might breathe new life into the design. The Metroliner featured sleeker engine cowlings and slightly more powerful engines and weather radar than its predecessor. And because the 340 had been especially loud, Convair took pains to soundproof the 440 and hush its engine exhaust. Convair also offered an option to extend coach class by eight seats, to 52, with the removal of carry-on closets.

Despite the refinements, the airplane was no match for the quieter, more powerful Viscount and other aircraft of the dawning turboprop age (the Convair 580, more or less a Convair-Liner with turboprop engines, was a failure). Only 199 of the Metroliners were manufactured, though airlines upgraded more than 100 of their 340s to 440s with kits provided by Convair.

Ultimately, nearly 1,100 of the 240/340/440-series airplanes were built. The U.S. military was the biggest customer, ordering almost 500 aircraft. The most famous of these was the Air Force's T-29 "Flying Classroom," used to train bombardiers and navigators. Others, such as the C-131 and the Navy's R4Y, were used for transport, medical evacuation, missile tracking, photo-surveying, and electronics testing.

Rovos' two aircraft were among the 30 or so produced as C-131D Samaritan transports. For more than 30 years they flew Air Force officials and provided medevac service. In the late 1980s they were retired to the Davis-Monthan Air Force Base storage facility in Arizona, and in 1991 they were transferred to the custody of the U.S. Air Force Museum in Dayton, Ohio (though the airplanes belonged to the museum, they stayed in Arizona). The museum swapped them for an airworthy Beech 18 owned by Long Island trader Bob Smirnow. In 1992, Smirnow sold the C-131s to Rolando Canedo, owner of Bolivia-based Líneas Aéreas Canedo.

Canedo ferried the aircraft to Bolivia and refurbished the interiors and added seats, replaced hoses and hydraulics, rebuilt the engines, and added GPS instruments. Because the airplanes were no longer owned by the U.S. Air Force, Bolivian aviation authorities certified them for airworthiness as Convair 440s. LAC operated the aircraft until 2001, when Canedo decided he might retire and sell the airplanes.

Just as Canedo was contemplating

ROVOS RAIL PHOTO LIBRARY

Vos rebuilt not just the rail cars but the original station, where he greets guests (below). Rovos technicians gain easy access to the pampered Pratt & Whitney R-2800s within the Convair's foldout "orange peel" cowling (right).

OPPOSITE BOTTOM: NASM 00023486 (SWISSAIR PHOTO+ VERMESSUNGEN AG ZURICH NEG. #7453, METROPOLOTON)

retirement, Rovos Rail was facing a crisis. Zimbabwe, through which Rovos ran its main route—Pretoria to the town of Victoria Falls—was crumbling under the rule of President Robert Mugabe's Zimbabwe African National Union-Patriotic Front and its campaign to redistribute white-owned land to poor blacks.

In March 2000, faced with problems operating the trains in Zimbabwe and widespread flooding in the region, Vos concluded that it was no longer wise to run a luxury train through the Zimbabwe countryside. He plotted a route from Pretoria through Kruger National Park and on to Pietersburg, followed by a final leg to Victoria Falls in a chartered DC-3 or -4. (After much tinkering, the trip now consists of rail legs from Pretoria to Kapama Game Reserve and then Kapama to Pietersburg, followed by a flight into Livingstone, on the Zambian side of the falls. Rovos offers the one-way journey weekly.)

Though the charters served admirably, Vos wanted an aircraft he could modify for luxury. He searched the trades and the Internet for airplanes that would match the nostalgic allure of his rail cars. His heart was set on a piston-engine airliner that was pressurized and powerful enough to fly over bad weather and take off in the heat and humidity that thinned the air in Africa. He also needed to carry 44 passengers—the capacity of one rail dining car and about the number of tickets to turn a profit on a run to Victoria Falls.

There wasn't much out there—just a few DC-4s, DC-6s, and the Convairs. He sent an engineer to Bolivia to evaluate LAC's two 440s, which he'd read about online. The engineer's report came back positive, and in May 2001 Vos personally inspected the airplanes.

To assure Vos that the airplanes could operate at altitude, LAC flew him on a round trip from its 8,360-foot-elevation base at Cochabamba to La Paz—at 13,325 feet, the world's highest international airport. Vos also insisted LAC crunch numbers for what he said might be a typical Rovos Air trip: "A flight from Johannesburg to Livingstone…which is 5,500-odd feet down to 4,000-odd feet at [95 degrees Fahrenheit] with 44 people." The calculations said the 440s could make the trip. "On the strength of that, I bought these things," says Vos. Two airliners, $1 million each.

Because the aircraft had flown only intermittently for the Air Force, and because they operated at altitude in Bolivia, the airframes were in good condition with almost no corrosion, but they were out of compliance with international airworthiness directives. Vos removed the airplanes' insulation and wiring, the avionics were again updated, and the instruments reconfigured and modernized.

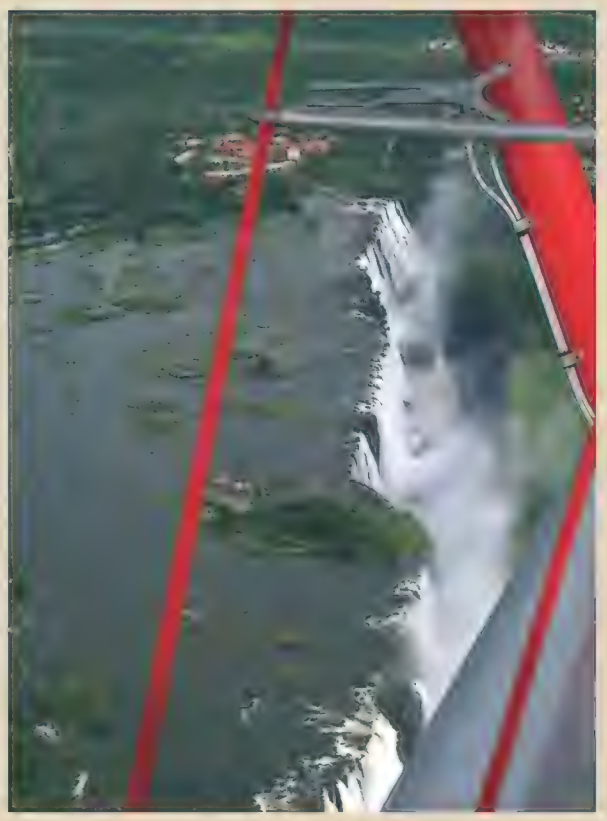
One instrument that remained was the engine analyzer, a circular display near the flight engineer's seat. The flight engineer's main job, after starting the Pratt & Whitney R-2800 engines, is to monitor them during flight. "That instrument enables us to tell if the spark plug is firing or if the lead that's going into it is performing," says Theo Munro, a Rovos flight engineer who worked on DC-3s and DC-4s for 30 years in the South African air force. The analyzer can spot problems before they turn into real trouble. Its backlit sine waves pulse in synch with the engines and look like an electrocardiogram ("We often joke that that's the captain's heart rate," says Rovos Air operations chief Stuart Vere-Russell).

The Convair's signature system is its engine augmenter, which uses heat from the exhaust to warm outside air it has collected. The warmed air can be used to heat the cabin and de-ice the leading edges of the wings and stabilizers. In addition to warming the aircraft, the augmenter also helps cool the engines. It uses the vacuum induced by the high-speed flow of the exhaust gases as they pass through the exhaust tube to suck ambient air through the engine nacelles and reduce the need for cowl flaps. Convair boasted that the system added about 10 mph to cruising speed and 2,000 pounds of payload.

Once the restoration was complete, Vos had the aircraft weighed for local aviation authorities. "The weight ended up 2,400 pounds more than had been

Vic Falls Aerial Adventures

Only from the air can visitors see the entire mile-long "curtain" of Victoria Falls. Several companies offer very civilized helicopter tours of the falls and the surrounding region (some even set you down for picnics on secluded Zambezi river beaches and islands), but these open-cockpit alternatives are more adventurous.



Batoka Sky's microlights (two-seat ultralight aircraft) overfly the falls close enough for passengers to feel the mist rising from the Batoka Gorge. Cameras and video equipment are prohibited, but $10 buys snapshots of your trip taken by a wing-mounted camera. Fifteen minutes over Victoria Falls, $70; 30 minutes over the falls, Batoka Gorge, and Mosi Oa Tunya game park, $85. www.batokasky.com

United Air Charters' De Havilland DH82 Tiger Moth biplane cruises at 90 mph. Don a leather helmet and goggles and listen to the pilot yell "Contact!" as the ground crew props the engine. Cameras and video equipment allowed aboard during flight. Twenty minutes over Victoria Falls, $115; 30 minutes over the falls and Mosi Oa Tunya game park: $160. www.uaczam.com

Guests view spellbinding African countryside from airy observation cars (above), which are drawn by a German...

declared when we purchased it," says Vos. "So hello! We're 11, 12 passengers down on [weight] numbers we expected." Vos thinks Canedo simply passed on a number the Bolivians may have been given when they bought the airplanes. Canedo disputes the charge, but it doesn't change the situation. "We've got airplanes now that cannot fulfill the job they were purchased for," Vos says.

When the other passengers arrived at Pietersburg airport, it was evident that the story of van Niewehuizen's confrontation with the New Yorkers had made the rounds. I'd seen him only briefly since he'd stormed off the Jeep. Now he'd reappeared to shepherd his passengers through security and immigration. His mood had improved: When asked about the New Yorkers' newly condensed luggage, he responded with a smile and a story about a Rovos Air captain who had ordered the contents of a Convair's baggage hold offloaded and set on the ramp so that the entire group of passengers could repack.

Even small adjustments to the Convairs' payloads make a difference to weight and fuel numbers, and thus safety and profit. Having already removed a row of unsold seats to compensate for 175 pounds of freeloader (me), Rovos banished Wolman to the twin-engine Piper that would follow the Convair to Zambia with the extra luggage. When it can, Rovos flies the lighter of its two 440s. Metroliner ZS-BRV weighs in at approximately 500 pounds less than its virtually identical-looking companion, ZS-ARV (though the latter sports a larger nosecone), yet even the lighter airplane suffers, eating up lots of runway during takeoff from Pietersburg before settling into a 20-minute climb to 13,000 feet.

Flown nonstop to Livingstone, the Convairs might cover the 525 miles in two hours and 10 minutes. But because the 440s shave weight by leaving Pietersburg with a partial fuel load, they must refuel at Francistown, Botswana, after just 70 minutes in the air. Then there is a 75-minute flight to Livingstone.

Once aboard the Convair, I felt bad for Wolman, who'd had to climb over suitcases and duffel bags to wedge himself in the Piper. Aboard the Convair, I jaunted down cushy green carpeting and plopped myself into a wide leather seat. Above my head, shallow shelves just deep enough to hold coats and hats ran the lengths of the cabin walls. I also took note of the Art Deco-style Convair nameplates on the seat armrests, and the tasteful porthole curtains. And then there was the *pièce de résistance*: a pedal-operated rail car commode installed at the behest of Vos. Considering the weight limitations, a 25-pound toilet (and the 20 liters of flush water) seems an odd choice, but it played to rave reviews.

...Borsig Class 19D locomotive (opposite). Vos names engines after his children, this one for son Shaun. Stops at nature parks provide wildlife closeups (below).

"When you sat on the toilet your knees weren't up to your chin," said passenger Rose Orenstein of Lake Tahoe, Nevada. "It just felt reasonable."

The refueling stop in Botswana was made more interesting by heavy rain that had cooled the air but washed out local electricity. Passengers milled about the darkened Francistown International Airport terminal drinking from juice boxes and trading stories about game preserves. Others stood outside and smoked.

After an hour, the flight attendants announced that the airplane was fueled, and the 41 of us tramped across the ramp and up the Convair's extendable airstairs to our seats. The rain had abated to a drizzle. The second leg began with another long takeoff roll and shallow ascent over the flooded bush surrounding the airport.

Service aboard the aircraft was meticulous and slightly over the top. (The same was true of the train: Upon returning to a suite from dinner, one finds a bottle of champagne sitting on a turned-down bed.) The flight attendants began by passing out embroidered tablecloths and long-stem yellow roses, followed with an offering of wine or mango-orange juice. Next came a light lunch of cheese and cucumber on a baguette, beef and onion skewers, a phyllo dough pastry, a spring roll, and a spicy fritter. Delicious.

The day's early start—8:30 a.m.—and the dull noise of the slow-spinning (just 1,000 rpm) propellers encouraged napping, but lunch renewed the passengers' interest in the landscape. At low altitude and low speed, Africa can be absorbed on a per-village basis. South Africa's countryside—its low Drakensberg Mountains, paved roads, and occasional farms—looks like rural Virginia or Kentucky. But Botswana, Zimbabwe, and Zambia scrolled steadily underneath us like the Africa of *National Geographic* articles: squat trees, muddy rivers, and patches of red soil. A commotion in the cabin marked the arrival of the money shot: Mist from Victoria Falls creeping upward in wisps above the Batoka Gorge. Moments later, the bump of the tires touching down and the roar of the propellers reversing signaled the end of our flight.

In the time it took to taxi and deplane, enthusiasm for the day's adventure had vanished. Everybody wanted to be there already, to relax poolside at a posh hotel before venturing to the falls or nearby game parks. In the Livingstone airport parking lot, hotel shuttles idled as we awaited the luggage airplane, which was 30 minutes behind us. The fogged-in aircraft, the refueling stop, the lengthy wait for our bags—these would have had U.S. travelers screaming. But here such complications are shrugged off as "just Africa."

We were nearly two hours behind schedule, and Rose Orenstein's husband George had taken notice. "It's been about six hours since we got off the train," he calculated. "Despite all of the elegance, and all the comforts, and the pure joy of this flight, the reality is if you have to get someplace, this is a thing of the past." Christof Helbing of Switzerland appraised the day more succinctly: "It was nice. Not a second time. Once was enough."

Vapor trails corkscrew off the 440's prop tips on takeoff when a shower soaks the ground—and the air.

Vos recognizes that the Convairs are not ideal, but he has no plans to sell them. Operations chief Vere-Russell would like to see a change to a jet, perhaps a Fokker 28. "From a business point of view, an economical point of view, we definitely need a stronger, more powerful airplane," he says. But he can sympathize with Vos as well. "[Rohan] has put a hell of a lot of money into these things. To just sort of up and leave them...he's quite hesitant to do that."

Even with the delays, I wasn't sure that such a change was necessary. By definition, a journey with Rovos is not point-to-point transportation. A ticket buys you the time to soak up the finer details of a vista or a passing town, of a steam locomotive or a half-century-old airliner, of fine food and the companionship of fellow travelers. Rovos marketing agent David Patrick had once told me Vos' "whole ethos behind this thing was that he wanted to give people a chance to relax and to restore the lost art of conversation." When the luggage (and Wolman) landed and passengers hugged and parted company for the last time to claim their bags, I couldn't help but think he'd succeeded.

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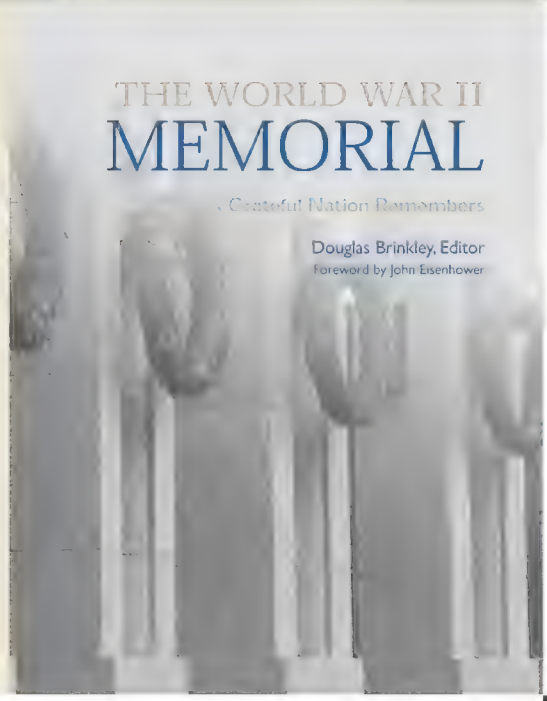

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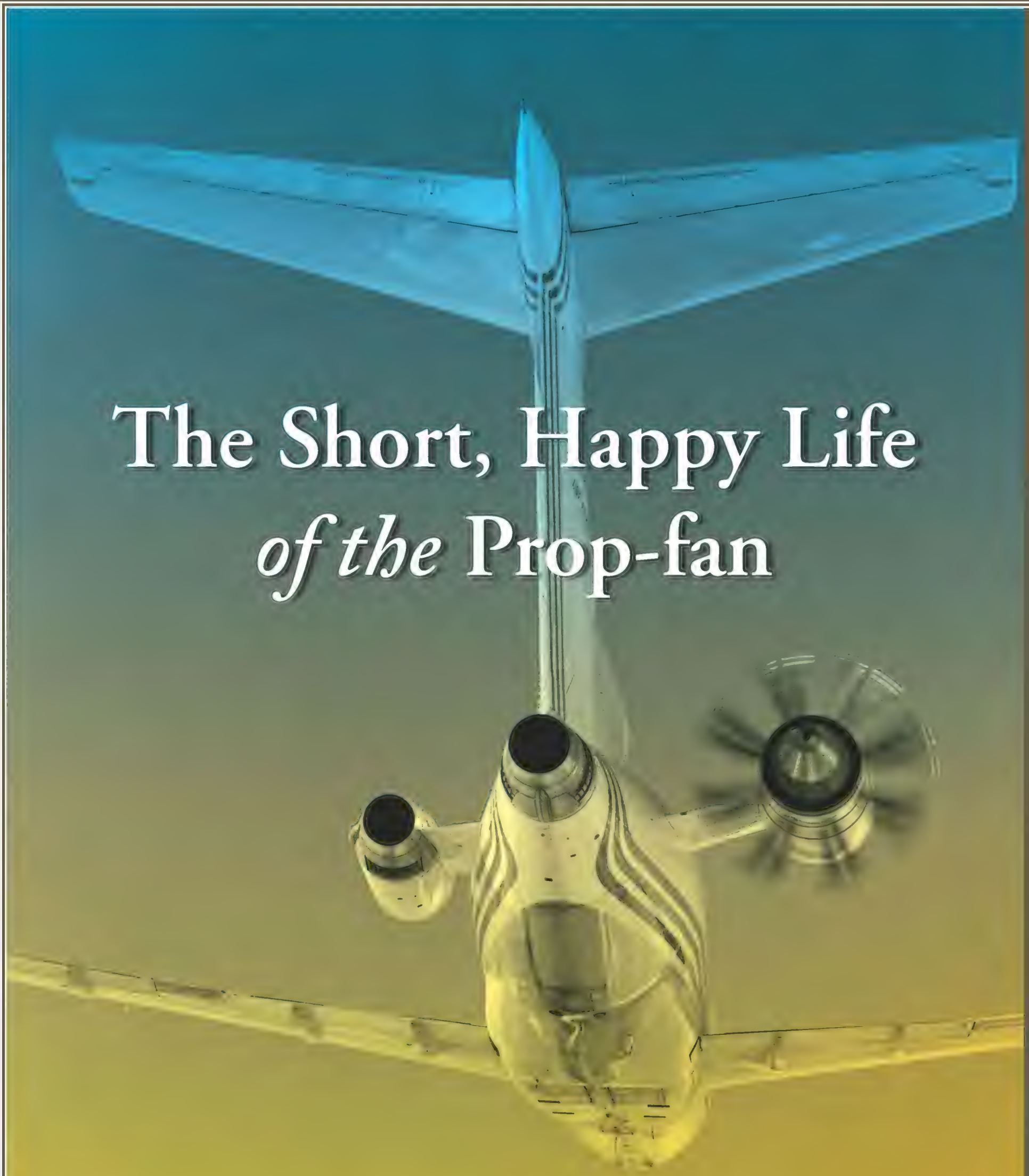


Fuel's expensive again. Here's what happened the last time there was a crunch. | BY BILL SWEETMAN

Looming like an alien craft above the General Electric stand at the 1985 Paris Air Show was an egg-shaped engine nacelle that had, mounted on its smaller end, two rows of scimitar-like propeller blades 12 feet in diameter. The GE people called this new prop-fan engine an UnDucted Fan, and it was the most radical feature of the proposed Boeing 7J7. "2,500 Days" read the Boeing brochures that papered the company's stand at Paris—within seven years, Boeing proposed to create around this engine a revolutionary 150-seat airliner that would burn only half as much fuel as the new and yet-to-fly Airbus A320, which was about the same size.

MIKE VINES

GE began flight testing the UnDucted Fan aboard a Boeing 727 in 1986 (opposite). A year earlier, at the Paris airshow, it was touted as the engine of the future (above).

OPPOSITE: THE BOEING COMPANY

But by the time a real UDF flew at an airshow in September 1988, the much-hyped project was dead, a victim of misread history and a changing economic climate. For a brief period, though, prop-fans, a new class of engines that marked a return to propeller blades, but of an advanced type, held center stage as the saviors of the airline industry.

Prop-fans originated, in part, in two wars in the Middle East. The 1967 Six-Day War resulted in Israel's annexation of vast areas of neighboring Arab territory. The Arabs struck back, launching the 1973 Yom Kippur war, this time imposing an oil embargo on the United States, Europe, and Japan. The embargo drove fuel prices to new heights with little warning, and airlines suffered staggering losses. The stage was set for technology to come to the rescue.

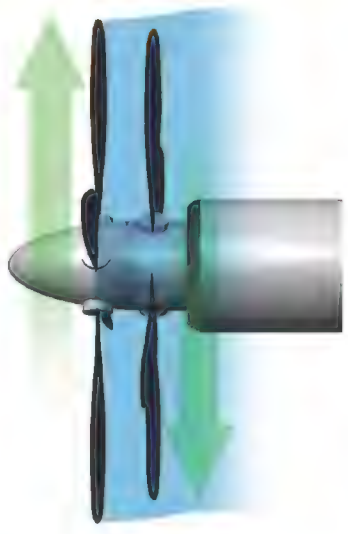
In the United States, NASA's Lewis Research Center in Cleveland, Ohio, is the center for propulsion research. Dan Mikkelson, an engineer there, knew that the secret to an ultra-efficient engine was an extreme bypass ratio, a number describing the proportion of cold air volume driven rearward by the engine's fan to the volume of hot gases coming from the compressor-turbine core. A propeller would be more fuel-efficient than any jet, but propellers couldn't operate at high Mach numbers, and passengers would not want to go back to eight-hour transcontinental flights. Mikkelson and Carl Rohrbach, a veteran engineer at prop maker Hamilton Standard, "thrashed ideas back and forth," Mikkelson recalls, and worked out the broad outlines of a radical propeller that would hold its own against a jet, enabling an aircraft to cruise at up to Mach 0.8.

Out of this emerged the Advanced Turboprop Project. Announced in an October 1975 technical paper, it promised massive fuel savings over a conventional engine: 30 to 35 percent, says Mikkelson—and many people hated it. "The old guys within the airlines were deaf to it," Mikkelson says. "They remembered the old days with piston engines, with blades falling off." When fears arose among airline officials that the word "turboprop" would meet with consumer resistance, the term "prop-fan" was used in a poll of United Airlines passengers. It worked: 50 percent of the respondents said they'd fly on a prop-fan-powered airliner. Hamilton Standard and NASA continued to support the project, but it moved forward in slow, careful steps, and it was not until 1981 that Hamilton Standard received a contract to fly a full-size working version.

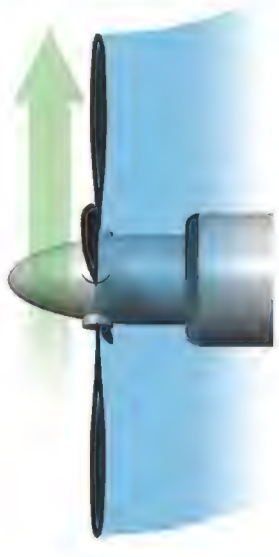
In 1980 and '81, following the Iranian revolution and the Iran-Iraq war, fuel prices made another painful jump, one that most oil market experts thought

THE BOEING COMPANY

Boeing's 150-seat 7J7 concept (left) would meld prop-fan technology and lightweight composite structure to deliver big gains in fuel efficiency.



Counter-rotating props double the working blade area without increasing the diameter of the prop disc. They also recover some of the energy...



...lost to the "swirl" of air emerging from a single propeller disc. The swirl directs part of the thrust energy off to one side instead of directly aft, the way a turbojet's exhaust does.

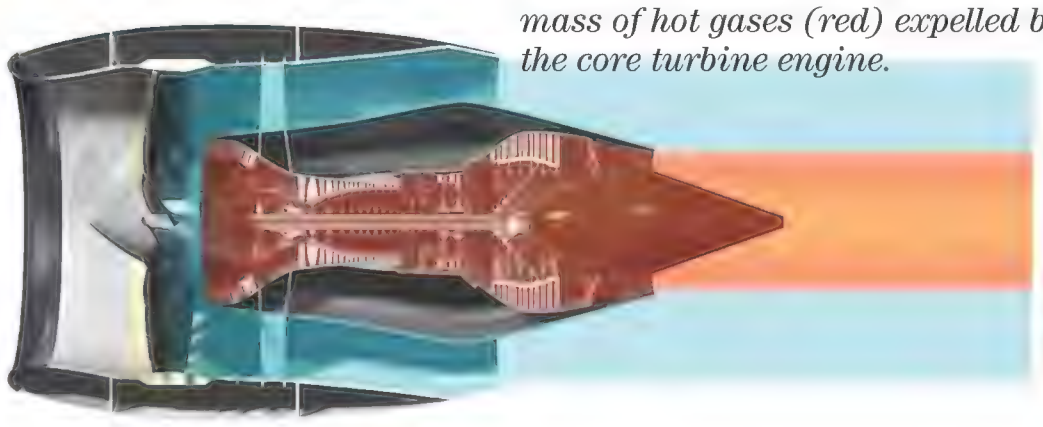
would be more than temporary. Bob Conboy, a market analyst who joined GE from Pratt & Whitney in 1980, recalls, "We had decided that fuel was going to rise to $2 or $2.20 per gallon by the mid- to late 1980s."

In 1981, Art Adamson, GE's head of advanced design, formed a team backed by Brian Rowe, senior vice president in charge of GE's aircraft engine unit, to explore more efficient engine designs. At the time, the company's CFM56 turbofan engine was being threatened by the new V2500, developed by International Aero Engines (comprising Pratt & Whitney, Rolls-Royce, Japanese Aero Engines, and Germany's MTU) and promoted as more efficient. "We never believed it," Rowe recalls. But the perception was that GE's technology was obsolete. Adamson's team produced what Conboy calls "a really innovative design, an example of what drives the whole industry."

Unveiled in 1983, GE's innovative UDF took NASA by complete surprise, but it galvanized interest in the new propellers. It was bigger and more powerful than the NASA engine, but it would fly earlier, in late 1986. After Boeing's '85 Paris offensive, Pratt & Whitney, Hamilton Standard, and Allison teamed up to offer the 578-DX, based on the NASA research. Both teams offered propellers with two rows of blades spinning in opposite directions to reduce losses due to "swirl"—energy wasted in imparting spin to the air behind the airplane. Both would be installed on the airplane's tail, not under the wings, to allow room for the propeller disc and to keep noise out of the cabin. "The rear row of blades has to chop through the wakes of the front row," says Hamilton Standard's Colman Shattuck, an engineer on Rohrbach's team. "It's a very good noise generator."

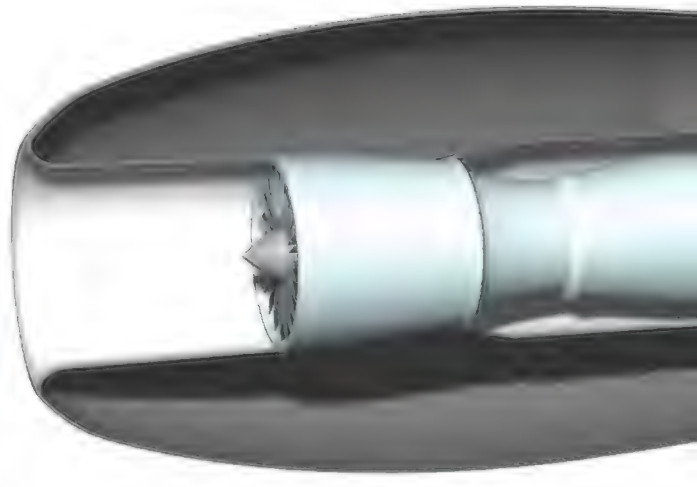
The big difference between the two designs was how the propellers were driven. The core of a turbine spins at tens of thousands of revolutions per minute, and to transfer power to a propeller or fan, traditional design relied on some form of gearing. The Allison-P&W team saw no problem with driving the radical new propellers via a 13-

Bypass ratio in turbofan engines is the ratio of the mass of cool air (blue) propelled by the fan to the mass of hot gases (red) expelled by the core turbine engine.



JOHN MACNEILL (4)

GE's UDF combined counter-rotating external fan blades with two internal turbine stages (red, green) that rotated in opposite directions. Exhaust from the core gas turbine (white) drove them.

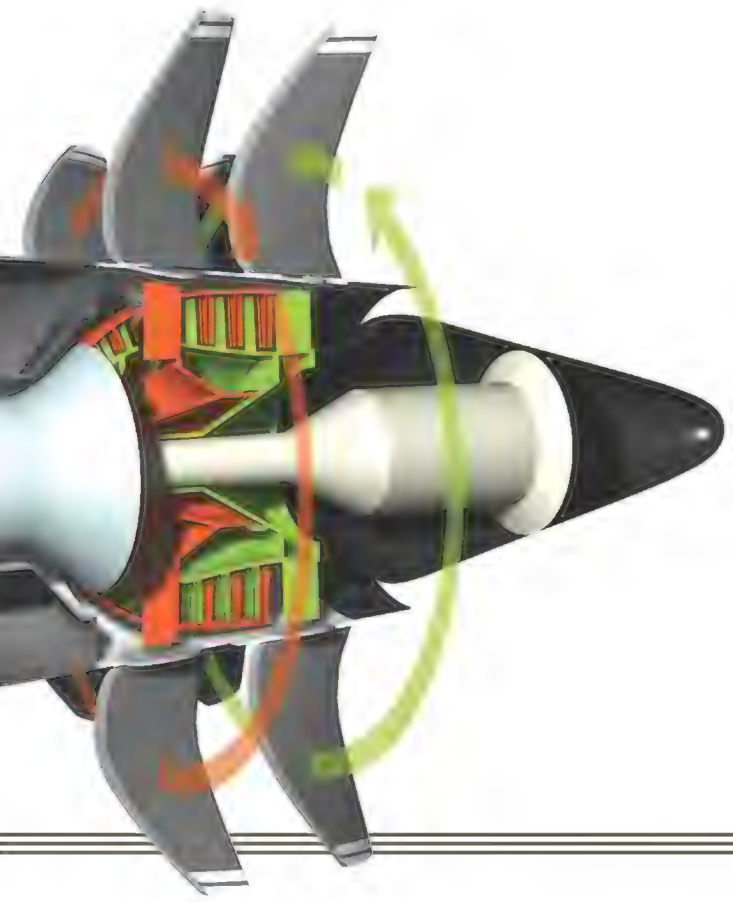


to-1 reduction gearbox, similar to the ones they'd used for years on the venerable T56 turboprop, which powered the Air Force's Lockheed C-130. But Rowe and GE disliked gearboxes, which were heavy and costly to maintain.

Boeing's Alan Mulally, now president of the company's commercial airplanes division, headed engineering on the 7J7 project from start to finish; he calls Adamson's solution "really, really cool," and it's hard to disagree. The UDF blades were powered directly and gearlessly by a turbine, driven by hot gas from the engine. The two rows of propeller blades were each anchored to multiple rows of turbine blades.

Conventional turboprops hit a wall when the combined forward speed of the airplane and the rotational speed of the propeller tips exceeds Mach 1, resulting in shock waves. The problem was that the rotational speed of the propeller was limited to only a few hundred rpms because the blade tips could exceed Mach 1 by only a small fraction; above that, efficiency plummets. But that speed was uncomfortably low for a turbine. A conventional turbine would have to be very large, with lots of stages, and each rotating stage would be followed by a fixed "stator," turning the flow so it hit the next turbine wheel at the right angle to convey force.

What was unique in Adamson's design, which had been refined by engineer K.O. Johnson, was that in profile,



GENERAL ELECTRIC COMPANY

Composite UDF blades pivot in unison to bite the air at just the right angle. Designers made the forward and aft blades in different sizes to reduce vibration.

the counter-rotating turbine stages were interlaced; the direction in which each row of blades spun was the opposite of the direction of the stages immediately upstream and downstream of it. The design had no stators, and the relative velocity between each stage was doubled. Counter-rotation effectively doubled the turbine's rpm, so the turbine could be made smaller, simpler, and more efficient.

But think about the mechanics. The turbine blades that drove the aft propeller were attached to a solid shaft in conventional bearings. The turbine stages driving the front propeller were riding outside the aft set and could not reach a central shaft. The turbine blades were attached at the tip to an outer case, which was carried on inter-stage bearings and a ring bearing at the rear of the nacelle. This design had to allow for thermal expansion and the load imbalances that would occur if a propeller blade broke off.

It was vital that the blades be lightweight so that the engine would survive if a blade separated. The UDF would have blades made from carbon fiber composite materials.

The new engine offered enormous potential but presented equally large risks. Rowe decided to fly a full-scale demonstrator in collaboration with Boeing, whose 727 test bed would fly in 1986. "I thought it was an engine of

Speed of the propeller was limited to only a few hundred revolutions per minute, because the blade tips could exceed Mach 1 by only a small fraction; above that, efficiency plummets.

What's a propfan (and what isn't)?

The prop-fan and UDF are unique among propellers because of their speed and power loading—the amount of power driving a propeller of given diameter. The thin blades and sweepback improved efficiency at transonic speeds, just as they did on an airplane wing. The airplane was subsonic, but the prop tips hit Mach 1.1 in a helical path.

Russia's Tu-95 bomber and its airliner derivative, the Tu-114, were designed in the 1950s and had jet-like swept wings. The turboprop-powered Tupolevs could sprint at Mach 0.78, but had to cruise at around Mach 0.7 for best range. Their 15,000-hp engines drove 18-foot counter-rotating propellers, requiring tall landing gear to keep the tips off the runways.

The Ukrainian Antonov An-70 and the yet-to-fly Airbus A400M cruise at up to Mach 0.72, about as fast as the jet-powered C-17 airlifter, but slower than commercial jets. They use large-diameter propellers, not prop-fans.

There is little interest in true high-speed propellers today. The latest conventional turbofans are more efficient than the engines of the mid-1980s, thanks to new fan aerodynamics and materials, so there is less to be gained by a move to a UDF-type engine. It's also questionable whether the prop-fan could meet current international noise rules.

Tu-95/Tu-114: Swept wings but straight propeller blades disqualify the big turboprop as a prop-fan.

MIKE VINES

ROLLS-ROYCE (2)

The Allison-Pratt & Whitney 578-DX prop-fan (left) had roots in NASA research but was meant for commercial airliners like the McDonnell Douglas MD-80 test demonstrator, shown above flying over California in 1989.

the future," he says, "something we ought to pursue." NASA headquarters ordered the Lewis center to support GE's privately funded efforts even though Lewis was developing its own engine. While GE regarded the UDF as a technology program, Boeing presented it as the engine that would power its newest airplane: the 150-seat 7J7.

The 7J7 represented a changing of the guard at Boeing, the first project to be launched by a new generation of leaders: Program chief Jim Johnson reported to a rising vice president named Phil Condit. The goal, Johnson said in early 1986, was to deliver an airplane that cost less per seat than the 737.

Veteran executives were more cautious. Mulally says today that "anyone who had worked with propellers really wanted to see the concept validated"—they wanted to be convinced that the new engine would be reliable. At Boeing, Mulally recalls, the 737 team proposed an improved, longer-range 737 that would cost far less to develop than a new airplane. But Boeing promoted the 7J7 and its UDF with an enthusiasm that rings in Mulally's voice almost two decades later. "It was a tremendous improvement," he says. "We could have delivered that airplane."

Johnson and Condit sold the 7J7 concept hard. Conboy says he took part in 50 presentations in 1987. In that year, Boeing settled on a larger design that used a little more fuel but offered six-abreast, twin-aisle coach seating, banishing the hated middle seat. The airplane was too large for the Allison-P&W 578-DX engine, and Boeing settled on GE's planned production UDF-based prop-fan, the GE36-C25.

The UDF made its first flight on August 20, 1986, aboard a Boeing 727 test bed. The tests encouraged Prop-Fan and UDF proponents, demonstrating that noise was a problem but not an insurmountable one. A February 1987 *Washington Post* headline read: "The aircraft engine of the future has propellers on it."

But not everyone was convinced. At the 1985 show, Jim Johnson wanted to pitch the 7J7 to Lufthansa's technical director, Reinhardt Abraham. His endorsement would be a huge blow to the A320; Johnson directed Rudy Hillinga, Boeing's chief salesman in Germany, to get Abraham to the Boeing 7J7 mockup at Paris.

But when Johnson showed Abraham a chart depicting the economic advantages of the 7J7 over the A320, the Lufthansa executive turned to Hillinga and said: "Rudy, get a photographer. We'll sign this, and I'll buy 20 of these aircraft if you can guarantee the figures."

Abraham knew perfectly well that Johnson was in no position to do that. What Abraham really wanted was a stretched 737, to turn up the competitive heat on Airbus.

Abraham wasn't the only skeptic. Conboy recalls that the airlines' reactions were "mixed from day one. We'd talk to the planning people and they'd say 'When can we have it?' But we never got an enthusiastic response from the operations people."

Gordon McKinzie, United Airlines' manager for new technology, recalls that Boeing couldn't settle on a design for the 7J7: "One week it was a single-aisle 90-passenger airplane, the next a 180-seat twin-aisle design. We saw things as being very fluid." The aircraft was neither as fast nor as flexible as the 757, which was, in McKinzie's view, "a great airplane." At best, McKinzie felt, United would "have taken on some aircraft, not a large acquisition, just to feel our way along."

Airbus' chief planner, Adam Brown, still believes that Boeing hyped the 7J7 in a bid to disrupt the A320 program. At the 1985 Paris show, Airbus faced the inevitable question: Was the company still confident in the A320's future? "We can go up against the 'magic aeroplane,' " Brown answered, "and we can beat it."

And beat it Airbus did. By the time Boeing decided to launch the stretch 737-400, Lufthansa had bought the A320.

GENERAL ELECTRIC COMPANY (2)

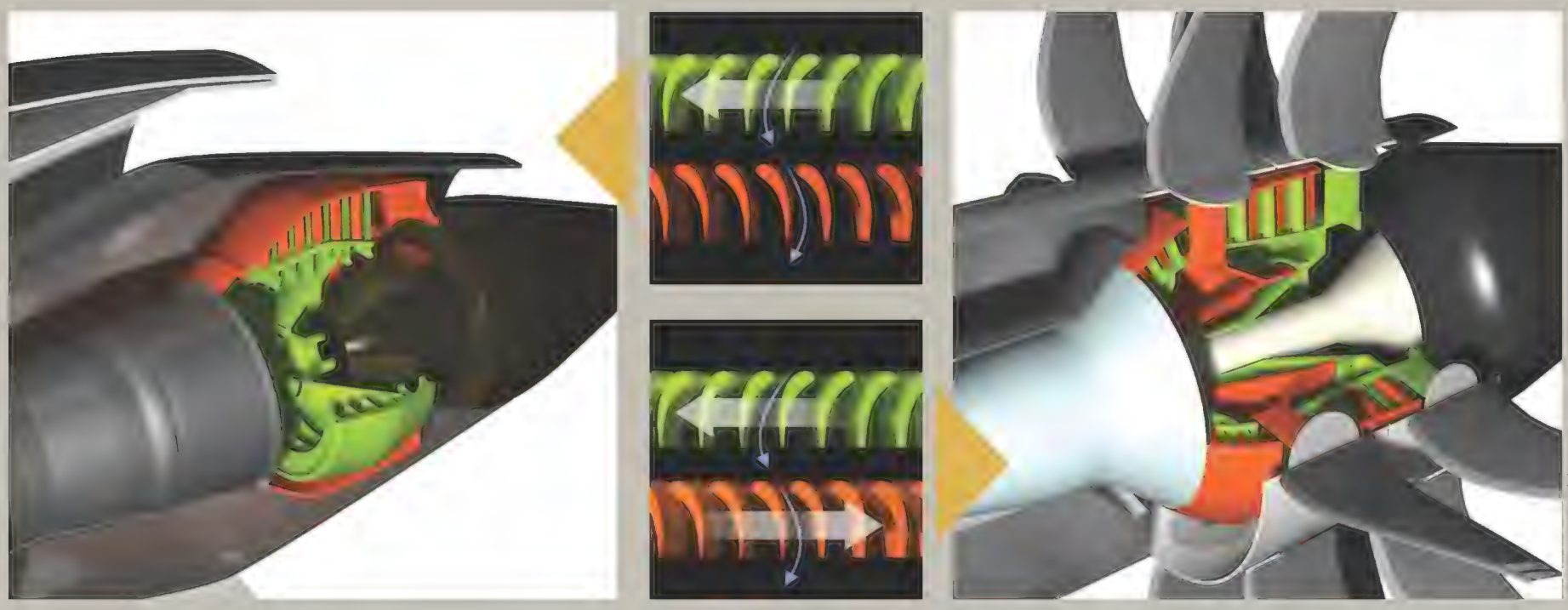
Execs Art Adamson, Ed Hood, and Brian Rowe (left to right) spent GE, not NASA, funds to design the UDF, which spent hours at the company's test site in Peebles, Ohio (above).

United and other airlines were anxious to start retiring their vast flocks of fuel-thirsty 727s. Northwest Airlines announced the first U.S. order for A320s—up to 100 airplanes—in late 1986. United followed suit within months.

Airbus stuck to its guns, Brown says today, because its studies showed that aft-engine aircraft were heavy, and maintenance costs would be higher.

Keeping the propeller blades light was vital so that the engine would survive if a blade separated. The blades were made of carbon fiber.

Soul of a new engine: The UDF was based on a pair of rotating turbine blade assemblies (red, green) nested one inside the other but with their blades interlaced. Conventional turbines used fixed stators to redirect airflow (center, top) while in the UDF, the counter-rotating turbines replaced stators with moving blades (center, bottom). One turbine blade assembly drove the forward propellers, the second drove the aft set.



JOHN MACNEILL (4)

MIKE VINES (2)

It wasn't until 1988 that a flying UDF went public, here aboard a MD-80 demonstrator at England's Farnborough Air Show.

"The answer depended very much on the price of fuel," says Brown. Only if the price of fuel remained high could the savings offset the greater price and complexity of a new aircraft. "With the projections that we were most comfortable with at the time, they couldn't beat the A320." And despite the forecasts, oil prices peaked in 1981. After the 1985 Paris show, Saudi Arabia, tired of losing market share while trying to stabilize the market on its own, and watching as the other OPEC members cheated, turned on the spigot. Jet fuel dropped to 85 cents a gallon.

But the biggest factor may have been unexpected developments at Boeing and GE. In 1981, the 737 was Boeing's weakest seller, and the company's objective was to sell 500 more and then close down the line. The 737-300 was launched with quieter engines as a quick fix, a move to help Boeing achieve that modest sales goal. Instead, 737-300 sales took off. By the end of 1987, Boeing had sold more than 1,000 of them, and each one had the previously slow-selling CFM56 engines from GE and its French partner, Snecma. The follow-on, -400, would use them as well. GE began to look at the CFM56 differently.

In 1987, the rival V2500 engine for the A320, which had beaten the CFM56 in early sales, ran into technical trouble. Its biggest customer, Lufthansa, switched to the CFM56. Suddenly, the CFM56 dominated a fast-growing market. GE's Brian Rowe could read the signs. "When the CFM56 took off, we thought, What the hell? All we'd be doing [by launching the UDF] is killing our own business." And while engineers expected that the UDF could be made reliable by earlier standards, turbofans were getting much, much better than that. "The biggest issue with the UDF," Mulally says now, "was to make it a simple engine and get the reliability up and the maintenance down."

At the end of August 1987, Boeing announced that the 7J7 had been postponed a year. (And Monty Python's dead parrot was "just resting.")

McDonnell Douglas tried to carry on with prop-fan development. It had the rear-engine MD-80, but it was losing ground to the A320 and 737. MDC fitted a UDF engine to an MD-80 in late 1987 and wanted to launch the UDF-powered MD-91 and -92 by July 1988. The company even saw a 300-aircraft market for a Navy patrol version of the MD-91. But GE wanted to see 100 to 150 airline orders before committing to the program. Recalls Conboy, "If people aren't going to buy it, there's not much you can do."

McDonnell Douglas' MD-80 was the only rear-engine U.S. airliner left when Boeing retired the 727, and the prop-fan blades discouraged wing mounting. After the 7J7 project faltered, the MD-91 and -92 would have been the only airframes suitable for the UDF. Turbofans powered the MD-90.

MIKE VINES (2)

Russia's Yak-42, a small, regional airliner, sported its own version of a propellerized turbine on this demonstrator at Farnborough.

GE and MDC flew the MD-80 to the Farnborough airshow in September 1988, but the effort was already out of steam now that McDonnell Douglas was building the MD-90 with a conventional engine. "We all shook hands and said that it was a valiant effort," says Conboy. MDC did fly the Allison-P&W engine on the MD-80 in 1989. "The operation was successful," says Al Novick, who was part of the Allison-P&W team, "but the patient died."

The UDF demonstrator is in the engine collection of the Smithsonian's National Air and Space Museum, and the Allison-P&W prototype is in a company training center in Indianapolis. But nobody involved in the prop-fan or UDF writes the experience off.

GE put the UDF's blade technology directly into the GE90, its most powerful commercial engine. "We trained a lot of good guys," Rowe says. One was Mike Benzakein, then the company's leading technologist. GE is still looking at counter-rotating turbines and fans, and came close to proposing such an engine for Boeing's new 7E7.

Colman Shattuck, the program's leader at Hamilton Standard (now Hamilton Sundstrand), says that the project was "one of the best times of my career" and that it spurred today's all-composite propeller technology. The firm's French subsidiary, Ratier-Figeac, makes the multi-blade propeller for the Airbus A400M military transport.

For Allison, the benefit had little to do with technology. "We got involved publicly with Boeing and Douglas," says Novick, "and it helped us tremendously in getting back into the commercial business." Embraer picked an Allison turbofan, the AE 3007, for its EMB-145 regional jet, and Rolls-Royce, which acquired Allison in 1995, cranks turbofans out by the boatload.

Mulally and Condit became the leaders of the next major Boeing project, the 777. It had little resemblance to the 7J7, but the underlying technologies and disciplines—computer-aided design and manufacture, and integrated electronics—were similar. Mulally quotes Boeing chairman Thornton "T." Wilson as saying that the 7J7 "was the best investment in aircraft development that Boeing ever made" and adds that "we could not have done the 777 without the 7J7." Condit went on to head Boeing until he resigned in late 2003, accepting responsibility for ethical and performance problems.

At the 2001 Paris Air Show, Mulally whipped the covers off another radical, rear-engine airplane, the tail-first Sonic Cruiser. In an echo of 1985, Boeing promised vast improvements over anything the competition could do. Like the 7J7, the Sonic Cruiser failed to ignite customer interest, and Boeing is pushing the 7E7, now redesignated the 787. Both aircraft offer more comfort with a lower fuel burn, Mulally says. "The cool story about the 7J7," Mulally says today, "is that it's exactly the same [idea] as the 7E7, but at a smaller size."

The Airbus A320 went on to become one of the most successful airliners in current production, second only to the 737 in total unit sales. Airbus' Adam Brown also compares the 787 to the 7J7. "The issue is whether the advanced-technology combination can give you a big enough gain in efficiency to supersede what's already on the market," he says.

And once again, the key to the fortunes of both companies could be the price of a barrel of oil.

McDonnell Douglas dropped the UDF (right, at its Farnborough debut) and by 1996 would do a stock-swap merger with Boeing.

When Stars Collide

Changes in gravitational fields send shudders across the universe. New detectors are watching for signs of their arrival.

BY TRUDY E. BELL

Neutron stars locked in orbit around each other, like the pair in this artist's concept, will shed energy in the form of gravitational waves while they spiral inward until, according to theory, they fuse into a single mass.

DANA BERRY/NASA GSFC

"We're not astronomers, yet. We're still instrument builders. We've built a telescope, but we haven't yet seen a star."

So Warren W. Johnson, Louisiana State University physics professor, summed up the current state of gravitational wave astronomy—a science with maybe a billion dollars invested in equipment worldwide and more than three decades of effort, but no direct detection of gravitational waves…yet. This fall could see the first, and scores of astronomers, physicists, and mathematicians around the world are watching detectors—indeed, have staked their careers on the belief that gravitational waves will be detected very soon.

What are gravitational waves? What would they tell us about the universe? And who cares whether they're detected?

Gravitational waves are ripples in space-time. That's the usual explanation offered to a lay audience, likening gravitational waves to the expanding circular waves seen when you throw a pebble into a pond. Not a bad analogy for invoking an image of crests and troughs radiating out from a disturbance. But that vivid comparison, of course, begs the question: What is space-time?

Space-time is what we live in—the three dimensions of space in which we all go to school or work, mow the lawn, and watch TV, plus the fourth dimension of time, in which we measure how long we take to do these things or note when we start and stop. Every one of us is constantly traveling through space-time, as Earth carries us around the sun and as the arrow of time inexorably carries us away from our births and toward our deaths.

Perhaps you have to be a physicist to truly visualize space-time in full four-dimensional splendor being warped by a passing gravitational wave, but even children can grasp the concept surprisingly accurately by imagining a red-and-white-checked tablecloth spread for a summer picnic. The tablecloth itself represents space-time, compressed from four dimensions into two; indeed, the checks can be used to specify locations in good old-fashioned X/Y coordinates ("the potato salad is 20 checks east and 15 checks north of the edge of the picnic table"). Juice splatters that stained three white checks in one area are embedded in the fabric of the tablecloth.

Now watch carefully. If the tablecloth around the juice stains is pulled on the fabric's bias, the square checks will elongate into diamond shapes, stretched in one direction and compressed in another. One pair of juice stains will move farther apart, and another pair will move closer together. The X/Y coordinates of all three juice stains on the tablecloth remain the same because the stains are firmly embedded in their checks; yet the distances between the three stains have changed because the tablecloth itself has been deformed.

That's exactly what passing gravitational waves are believed to do: They do not disturb the placement of objects in four-dimensional space-time, but they change the distance between them by stretching space-time itself in

one direction while compressing it in the perpendicular direction. That's what Albert Einstein mathematically predicted in 1916 in his general theory of relativity.

Einstein's theory grappled with changing gravitational fields, such as that of a massive star when it explodes and throws off most of its mass. Centuries earlier, Galileo, Kepler, and Newton had all derived equations that accurately described the behavior of gravity between ordinary objects and Earth or the mutual interaction among suns and planets in space—the equivalent of ants crawling across the checked tablecloth. But Einstein wondered exactly how objects could "sense" changes in other objects' positions or masses across the vacuum of space. So he invented a new concept of gravity. He realized that gravity could be explained as a curvature of space-time.

Mathematic calculations show that a single object drifting in a straight line at an unchanging velocity would remain embedded in space-time, sitting at the bottom of its gravitational well, its gravitational field a static force. But an object accelerating—exploding or rotating asymmetrically—or two objects revolving around each other would cause disturbances in space-time, or gravitational waves, which would propagate outward in all directions. The more massive the object(s) and the faster the motions, the greater the deformation of space-time, and the stronger the disturbances. And if the right kinds of instruments could be built, those gravitational waves should be detectable.

Who cares?

Physicists do. An unambiguous sign of gravitational waves would confirm the speed and characteristics of such waves as predicted by Einstein's general theory of relativity, which undergirds all modern physics of the very massive and the very fast.

And astronomers do. Gravitational waves carry information about extreme astronomical processes now unknowable any other way.

"All the light we see from an [exploding] star is just from individual atoms in its outer layers," explains Lee Samuel Finn, director of the Center for Gravitational Wave Physics at Pennsylvania State University in State College. "We can't peer into its thermonuclear engine. But gravitational waves come from its bulk matter, traveling through the outer layers without scattering, extinction, or reddening, letting us directly see the collapse of the stellar core."

Gravitational disturbances, like light and sound, move in waves with characteristics like frequency, wavelength, and strength that can vary over time. In fact, one type of detector is trying to convert gravitational vibrations into ordinary sound.

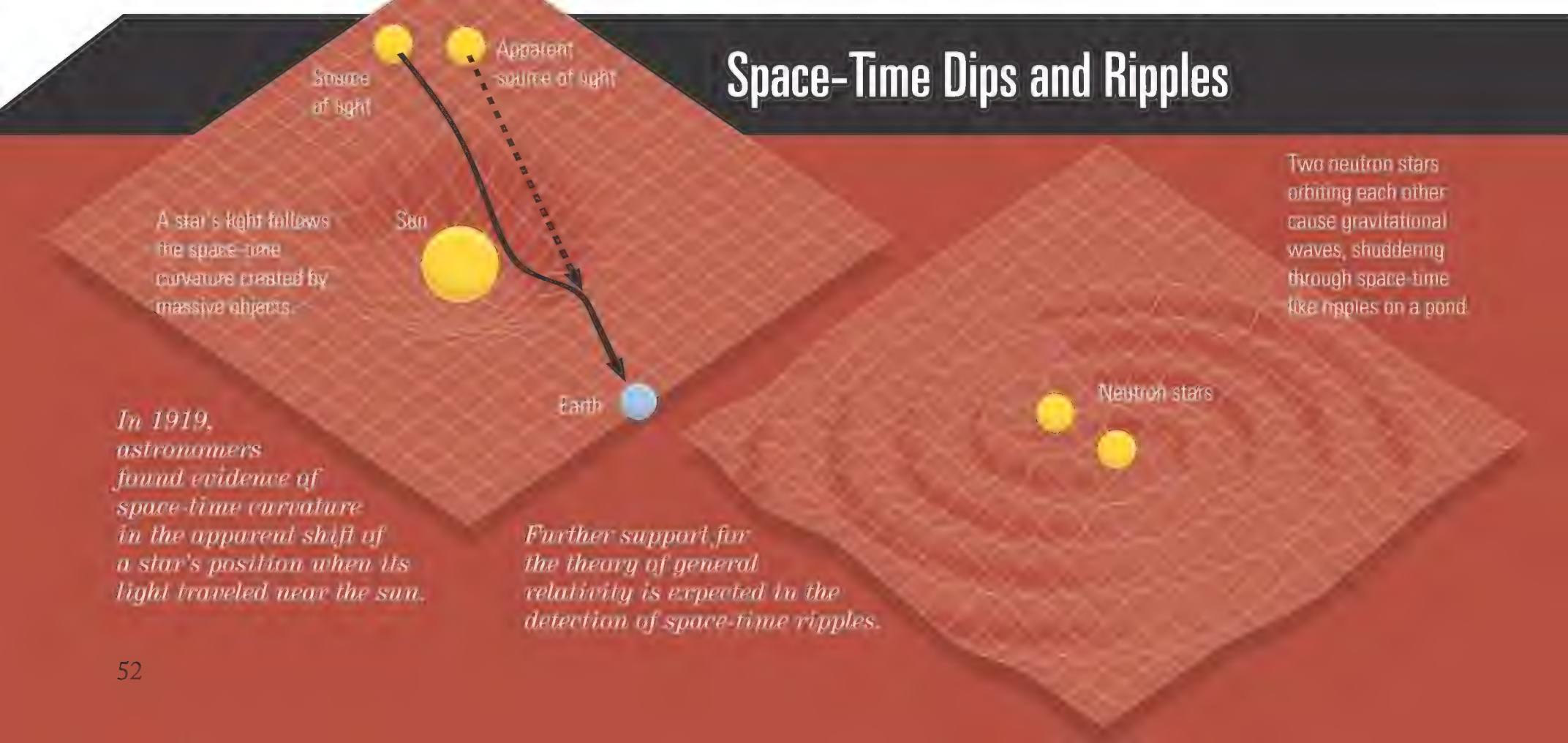
Hum a Few Bars

"We're like deaf people, watching other people's lips move and trees fall. We suspect there is sound, but we have never heard it, and can only guess how to build something that can detect its vibrations," explains Michael E. Zucker, a gravitational wave physicist who splits his time between the Massachusetts Institute of Technology and a gravitational wave detector outside Baton Rouge, Louisiana.

Among gravitational wave scientists, auditory analogies abound, and the analogies are apt. Gravitational waves are expected to arrive here at all frequencies and from all directions in space. Just as following a single conversation in a large cocktail party requires a listener to reject the background chatter and the clinking of glass and silver, the challenge of locating an individual source of a gravitational wave requires determining direction with two "ears," plus filtering out noise, including noise at the same frequency as the desired signal.

The oldest way of trying to detect gravitational waves is literally listening for them, using solid aluminum bars that function essentially as giant tuning forks. As you can make a tuning fork held near your mouth hum faintly if you sing at its resonant frequency, acoustic bar detectors are expected to hum when struck by a gravitational wave of the bar's resonant frequency.

Space-Time Dips and Ripples



Grad student Norbert Solomonson sits inside ALLEGRO on one of the rare occasions when its shell was opened. Warren Johnson (at left and below) and William Hamilton (below, on ladder) designed the solid aluminum cylinder (lower cylinder) suspended within the tank to vibrate like a tuning fork when struck by a gravitational wave.

LOUISIANA STATE UNIVERSITY (2)

One of the largest is ALLEGRO, which stands for A Louisiana Low-temperature Experiment and GRavitational wave Observatory. Designed and built by Louisiana State University's William O. Hamilton (professor emeritus of physics) and Warren Johnson, it is a huge aluminum tank on the ground floor of the Physics and Astronomy Building on the campus in Baton Rouge. The tank, its vacuum pump periodically emitting a stream of ticking bur-

bles, is surrounded with all manner of pipes, hoses, and other structures. Its external cylinder is basically a giant Thermos bottle, insulating a smaller chamber cooled to the temperature of liquid nitrogen (77 degrees Kelvin); that first chamber in turn insulates a second, chilled to the temperature of liquid helium, a mere 4.2 degrees K above absolute zero (the lowest temperature possible in nature).

Deep inside the frigid, dark inner chamber, in as rarefied a vacuum as is possible to produce in the atmosphere, is a two-and-a-half-ton solid cylinder of aluminum alloy suspended by a single titanium-alloy wire so that it hangs in exact balance. The bar's size, the properties of its aluminum, and the precision with which it was manufactured all contribute to its sensitivity and bandwidth: It is able to "hear" in two narrow bands near the resonant frequency of 900 Hertz. Should a gravitational wave of those frequencies pass through the bar, the wave should set the bar to ringing.

Theorists have predicted that certain classes of supernovae could produce gravitational waves at a frequency within ALLEGRO's bandwidth. Because the tone would be so extraordinarily faint (and inaudible anyway in a vacuum), delicate accelerometers are affixed to the bar's ends to sense minute accelerations of the bar produced by the vibration. The vacuum eliminates air molecules, whose bouncing off the metal surface might otherwise damp the faint vibration, and the extreme cold quiets the thermal jiggling of the bar's own molecules.

ALLEGRO has been listening for gravitational waves almost continuously since 1991. Because no scientist would believe any pulse to be a real gravitational wave unless it were registered nearly simultaneously by another detector of at least equal sensitivity, ALLEGRO has been collaborating with four other acoustic bar detectors in the United States and Europe.

So far, no pulse has been definitively proven to be due to a gravitational wave, but neither Hamilton nor Johnson is discouraged, primarily because astronomers now realize that the higher frequencies are likely to come from comparatively low-mass and infrequent astronomical events within our own galaxy. One hoped-for signal is a crescendoing and rising-pitch glissando from pairs of nearby neutron stars locked in an inward death spiral until they abruptly coalesce into a stellar-mass black hole, giving off one urgent accelerating chirp. That final death chirp is calculated to be brief, lasting maybe two minutes at most as it rises through ALLEGRO's narrow range of resonant frequencies. Says Johnson: "The gravitational chirp of this in-spiral event, if it were converted to sound waves, would sound like a big, low-pitched bird." The waves could be quite weak, depending on distance, but statistical calculations show that each year about a dozen pairs of neutron stars coalesce into black holes within "shouting" distance of Earth. Rarer still—maybe only three times a century in our galaxy—would be the scream of a massive star ending its life in a catastrophic supernova explosion. So, counting on luck as much as attention to detail, Hamilton and Johnson and ALLEGRO keep a patient vigil.

The Light Fantastic

Mirrors and lasers are the heart of a wholly different type of gravitational wave detector, which this fall will begin to record data at full sensitivity. This is the Laser Interferometer Gravitational-wave Observatory, or LIGO (pronounced LYE-go), its twin L-shaped detectors separated by more than 1,800 miles: one in the forests of Livingston, Louisiana, and the other

OPPOSITE: JUAN THOMASSIE

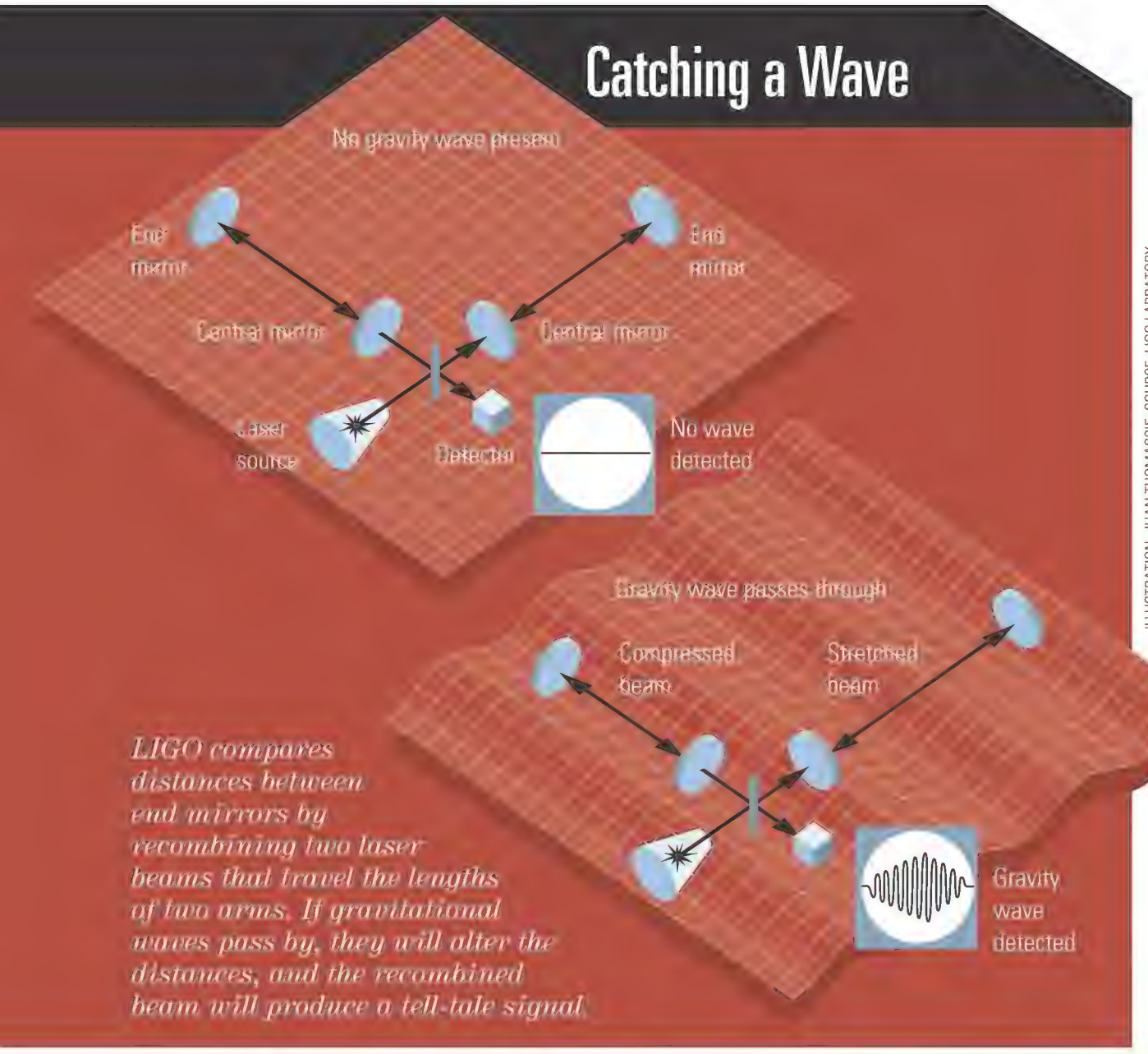


ILLUSTRATION: JUAN THOMASSIE; SOURCE: LIGO LABRATORY

in the desert of Hanford, Washington.

"LIGO is the biggest hole in the atmosphere ever built," quips LIGO-Livingston director Mike Zucker. Each LIGO facility consists of a pair of vacuum chambers, their ends meeting at right angles. Each chamber is monumental, measuring four feet in diameter and two and a half miles long.

LIGO does not listen for gravitational waves in the same way the acoustic bar detectors do. Its purpose is to directly measure the degree to which passing gravitational waves momentarily deform space-time itself. "General relativity predicts [a passing wave] will lengthen one arm and compress the other," says Rainer Weiss, emeritus physics professor at MIT. So if the two distant LIGO sites independently detected a tell-tale pattern of deflections nearly simultaneously, scientists would feel confident that they had observed a gravitational wave pass through Earth—and that, moreover, its measured behavior matched Einstein's prediction.

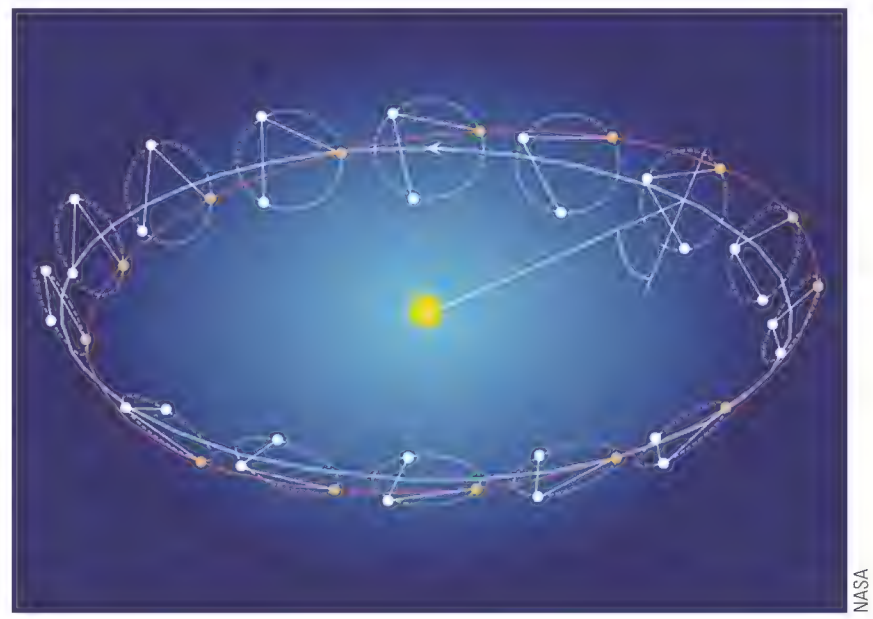
But what a measurement! The deflection of space-time is so minuscule that over the 2.5-mile lengths of LIGO's perpendicular arms—the arms at each site usefully if unoriginally dubbed X and Y—the scientists are preparing to measure deflections amounting to 10^{-16} centimeter, a thousandth the diameter of a sub-atomic neutron or proton.

Such a precise measurement presses science and engineering to the ragged edge of the possible. "Half of our technology is devoted to being able to detect a signal. The other half is devoted to identifying and eliminating sources of noise," Zucker says.

To detect a signal, LIGO operates with elegant simplicity: At the junction of the arms, the input beam of an infrared laser strikes a beam-splitter—essentially a half-reflective mirror—which directs half the beam down the length of vacuum in each arm. At the end of each arm, a mirror reflects the laser light back to the apex, where (after some 100 reflections back and forth) both split beams are recombined. Now here's the clever trick. The lengths of the arms are very slightly different, so the recombining laser beams will interfere destructively: The crests of the light waves in the laser beam returning from its trip down the X axis will cancel the troughs of the light waves returning from the Y axis. Thus, in the absence of gravitational waves, no light should reach the ultimate photo-detector. But should a passing gravitational wave distort space-time as Einstein predicted—and thus alter the relative lengths of LIGO's perpendicular X and Y arms—the recombining beams should interfere constructively: Light wave crests should fall on crests, troughs on troughs, light should shine on the ultimate photo-detector, and physicists the world over should dance.

Problem is, the living world is replete with sources of noise, most of which could distort the lengths of LIGO's arms by degrees far greater than the anticipated signal.

Daytime-warming expansions and nighttime-cooling contractions cause tiny but measurable differences in the



NASA

The Laser Interferometer Space Antenna will apply LIGO's principles to three spacecraft orbiting the sun in formation. Lasers will bounce beams between test masses on the spacecraft. The three-million-mile distance between each pair makes the system sensitive to extremely long wavelengths.

Laser interferometry detectors—one is in Washington state (right), one in Italy (below)—guide beams through long vacuum tubes set at right angles.

LIGO LIBRARY

CNRS PHOTOTHÈQUE/EGO-VIRGO

detector, as do the pounding of ocean waves on distant beaches, the hum from 60-Hertz power lines, and the thumping from tree farms right around the Livingston LIGO site, where mighty growling machines chop soft pines for paper. Thus the mirrors within the LIGO arms are suspended as pendulums from a heroic arrangement of springs and masses that damp seismic vibrations; recently, hydraulic actuators and electronic controls were added to actively counter seismic disturbances.

The twin LIGO detectors are sensitive to a wide range of frequencies, bracketing those detectable by the highly tuned ALLEGRO and other acoustic bar detectors: "from about 50 Hertz—an octave above the lowest note on a piano—to 10,000 Hertz, about that of the squeak of a mouse," says Weiss. And the LIGO detectors are not alone. Somewhat smaller versions are operating in Germany, Italy, and Japan. In addition to searching for signals from supernovae, astronomers hope they can capture the entire glissando accelerating up to the death chirp of binary neutron stars coalescing into black holes. LIGO is so sensitive, in fact, that eventually it should detect supernova explosions, in-spiraling neutron stars, and black holes swallowing gases (and burping) all the way out to the Virgo Cluster, some 45 million light-years away. "We're already within tasting distance of this!" Weiss exclaims.

Trailing Triangle

Gravitational astronomers' dearest hopes, however, lie on drawing boards. NASA and the European Space Agency are planning the Laser Interferometer Space Antenna, a constellation of three spacecraft that will orbit the sun in formation, 20 degrees behind Earth. When completed and launched in 2014, LISA will be the largest spaceborne instrument ever built.

Like LIGO, LISA would operate as an interferometer, but instead of being L-shaped with split beams recombined at the apex, LISA's three spacecraft will form an equilateral triangle, all three spacecraft sending beams that travel in both directions along each side and are reflected back by small free-floating test masses. Instead of being two and a half miles long, each of LISA's arms will be a little more than three million miles long—so long that the laser beam will need more than 16 seconds to travel its length.

Why such long arms? Signal. LISA is being designed to be sensitive to frequencies from below 0.1 Hertz down to 0.0001 Hertz—frequencies with wavelengths so long that the detector must be extremely large in order to sense them. "In that frequency range, the universe is doing a lot of big, exciting, violent stuff," says Robin "Tuck" Stebbins, the U.S. LISA project scientist at NASA's Goddard Space Flight Center in Greenbelt, Maryland. The number of sources giving off gravitational radiation at such long wavelengths is expected to be so huge that investigators worry about a "confusion limit," where only the loudest sources can be separated from the combined din. LISA's size will make it so much more sensitive than ALLEGRO and LIGO that Stebbins says, "If LISA doesn't see thousands of signals at turn-on, it's broken."

Astronomers have seen indirect evidence of gravitational waves, most recently in May, when NASA's Chandra X-ray Observatory measured the orbital period of two white dwarf stars circling each other. Einstein's theory predicts that massive in-spiraling stars will shed energy as gravitational waves and that, as the system loses energy, the two stars will move closer together. Although the Chandra observations confirm the prediction—the orbital period of the stars is decreasing, so they are drawing closer to each other—the cause of that behavior remains unproved. And it will remain so until LISA, operating in space, senses a movement in its tiny test masses of a half-billionth of an inch, the subtle shiver of a gravitational wave passing by.

Restore

A Bell That Didn't Ring | Bell P-59A

During the winter of 1939, with the Second World War under way and U.S. participation a distinct possibility, the Army Air Corps held a competition for a new souped-up pursuit aircraft. Among the 50 entries was the Model 16, submitted by the Bell Aircraft Corporation in Buffalo, New York. With a barrel-shaped fuselage and wing leading edges slightly swept, it was powered by a 1,250-horsepower Continental pusher engine with counter-rotating propellers behind the cockpit.

Six competitors made the first cut, including the Model 16, which the Army designated the XP-52. But it was cancelled in November 1941, replaced by another Bell design, a propeller-driven follow-on with a Pratt & Whitney R-2800 engine that delivered twice the horsepower. The Army called it the XP-59.

The XP-59 was also not to be. Seven months earlier, Army Air Corps Major General Henry H. Arnold had peered into the future and seen jets. The occasion was a visit to Great Britain, where he got his first look at the top-secret Gloster E-28/39 Pioneer, powered by the newly invented turbojet engine. Arnold promptly asked for, and received, permission to build the centrifugal-flow jet engine under license in the United States. Arnold asked the General Electric Company of Schenectady, New York, to be the prime contractor for 15 of the radical engines. The next day he asked Bell to develop a pursuit aircraft to attach them to.

Security was extreme. Instead of building the aircraft at its main plant, Bell bought an old automobile factory in Buffalo, swore a handful of engineers to secrecy, and put them to work behind blacked-out windows and guards.

The first XP-59A Airacomet was sent to Muroc Army Air Forces Base in California (later Edwards) by rail on September 12, 1942, under top-secret conditions. When it got there, the shrouded airplane was fitted with a dummy wooden propeller to prevent pointed questions. (The first XP-59A now hangs in the Milestones of Flight gallery at the National Air and Space Museum.)

Bell chief test pilot Robert Stanley flew the XP-59A to a cautious 100 feet on October 1 and to 10,000 feet the next day. A total of 66 Airacomets were built, but they were plagued with problems. The first engines, GE's I-As, produced less thrust than they weighed, and the airplane's top speed was a disappointing 404 mph at 25,000 feet. The Army was ambivalent about its new jet fighter. Performance improved a bit with the new General Electric I-16/J31 turbojet, which provided another 400 pounds of thrust, but the Airacomet did not perform that much better than the fastest piston-powered fighters: Lockheed's P-38 Lightning and North American's P-51 Mustang.

During the winter of 1943-44, the Army Air Forces reluctantly decided that nothing could turn the Airacomet into an outstanding high-performance fighter, so the single-engine, low-wing XP-59B

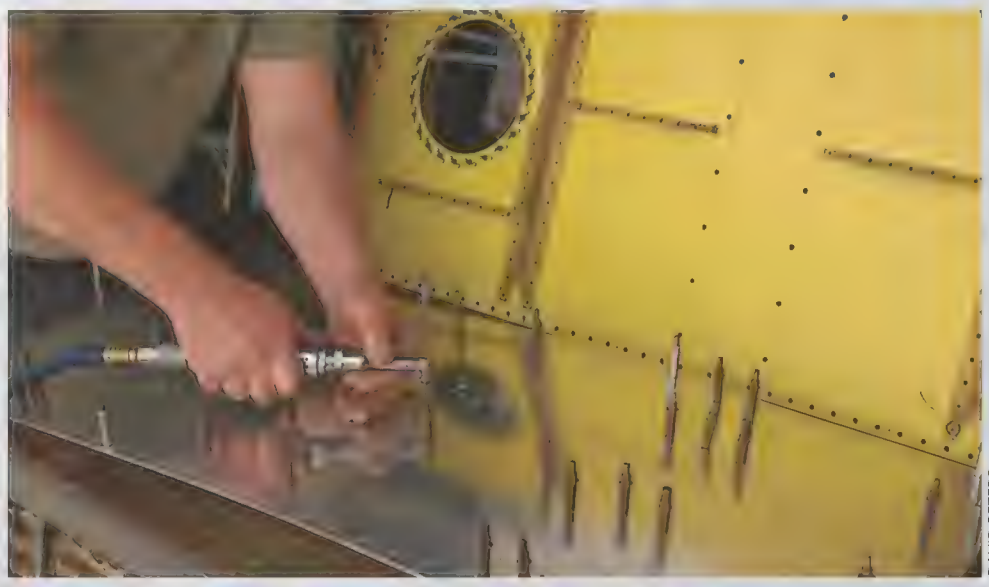
COURTESY PLANES OF FAME

The first design of what would become the jet-powered P-59 (above) called for propellers and a pusher engine.

It appears that the restoration team has a novel route of access: through the nose gear doors.

COURTESY PLANES OF FAME

Using Cleco pliers, Bob Velker works over a newly fabricated stress panel for the fuel system.



DAVID PETERS

ration

CAROLINE SHEEN

Ed Maloney (in checkered shirt) says the P-59 is "the Wright brothers airplane of the Jet Age." Fran Pieri places a new line in the intake and inspects a connection (below).

DAVID PETERS

follow-on was gradually abandoned. Lawrence D. Bell, the president of the company that had built it, did not lack for contracts. But he fumed when the contract for the B model was reassigned to Lockheed, where it morphed into the P-80 Shooting Star jet fighter.

Some survivors of the 66 P-59As were donated to technical schools to educate aspiring engineers and mechanics in the ways of jet aircraft. One recipient was California State University at San Luis Obispo, which got the seventh production model, a YP-59A numbered 42-108777. In the mid-1950s, the university put it up for sale. Edward Maloney, a historic-airplane buff, put in the winning bid. In 1957, Maloney founded the Planes of Fame air museum, now in Chino, California, and Valle-Williams, Arizona.

"This is the Wright brothers airplane of the Jet Age," Maloney says, "and the universities that got the other ones were turning them in for scrap." Only six Airacomets survived.

The Airacomet was parked outside at Claremont, the original location of the museum, for 36 years. In early 1991 it was put into the Fighter Rebuilders shop at Chino, owned by Steve Hinton, a renowned flier of vintage military aircraft. Fighter Rebuilders worked on the derelict fighter until late 1992, when the company was redirected to another project.

The following year, a small group of volunteers began turning out on Saturdays to restore the Airacomet. That deeply pleased its savior, who has also saved the world's only flyable Mitsubishi A6M5 Zero and Northrop N9MB Flying Wing, a Lockheed P-38J Lightning, and hundreds of other Planes of Fame treasures. "I'd like to be remembered for preserving these planes for future generations," says Maloney.

"When we got to it, a lot of parts were missing," says John A. Benjamin, an executive headhunter who works on the restoration in his free time. "We were missing the landing gear motor, the flap motor," and much else, including the canopy, Benjamin says. Worse, the I-16 engines were gone. Benjamin eventually found three I-16s in crates at a parts depot in Texas, where they had been sent to be installed in piston/jet engine Ryan FR-1 Fireballs. Other items were donated by aerospace companies, manufactured on the premises, or scrounged.

The Saturday morning irregulars have no blueprints for the P-59A because those were destroyed in a fire at the Bell plant in the 1960s. But they do have an Airacomet manual, which was used to put the airplanes together out of their crates. A lot of it, Benjamin says, is "just common sense."

And patience. "We're in our 11th year now," he continues. On nearby scaffolding lie the wings, stripped down to epoxy primer. "You put the engines in and it's downhill from there." Steve Hinton will fly the Airacomet next year and then take it on the airshow circuit. "It will be the oldest flying jet in the world," Benjamin adds with a trace of wonder. "Think about that."

—William E. Burrows

WHITE ROCKET

THOUSANDS OF PILOTS HAD THEIR SUPERSONIC BAPTISM IN NORTHROP'S T-38.

Twenty-three years old, fresh out of college, and a newly minted Air Force lieutenant, Howard Morland reported to Reese Air Force Base in Lubbock, Texas, for flight training in January 1966. In place of the fleet of Lockheed T-33s in which the previous generation of pilots had trained were precise rows of brand-new Northrop T-38 Talons blazing chalk-white under the winter sun. "There was nothing bird-like about them," Morland remembers. "Their wings were so far back and so small and thin that some of the new students believed that they functioned more like the feathers on an arrow, and that most of the lift came from the fuselage." Another rumor, likewise false, was that the airplane accelerated so rapidly on takeoff that the hydraulics couldn't get the wheels up before the aircraft exceeded the speed for wheels-down flight; little wings had to be added to the landing gear to hurry it along.

This was heady stuff, but shortly after Morland arrived, a student pilot who had recently soloed died in the crash of a T-38. "We all made a pilgrimage to the wreckage, a mile beyond the end of the runway," Morland recalls. "The ribs of the burned-out fuselage reminded me of the rotting carcass of a beached whale." Overhead, the number of T-38s practicing landings was unusually large. "Everybody had to go aloft and shake it off."

Morland spent a few months of flight training in the Cessna T-37, a fat, slug-

gish tadpole of a jet trainer. T-38s worked out on a parallel runway. "During every touch-and-go landing in the T-37, I would see a T-38 flash by at nearly twice my speed," he recalls. "It looked like a comic book superhero."

In those days, the very first lesson in the T-38 syllabus was supersonic flight at 40,000 feet. "In a matter of minutes we were going faster and higher than anyone outside the military aviation fraternity had ever gone," Morland says. Flying in supersonic formation, the wing kept bumping into an invisible but seemingly solid object: the lead airplane's shock wave.

The supersonic component is gone today, but much of the training syllabus is unchanged: formation, blind flying, slow flight, approaches to stalls, single-engine procedures, and landing...and landing...and landing.

Now, as then, landing is the great challenge of flying the T-38. "Instructors always did it right," Morland says, "but they seemed to be in conspiracy not to tell students the secret." The underlying aerodynamic problem was the tiny wing; it offered little forgiveness to a student who didn't have the proper attitude, height, and power as the runway threshold flashed beneath the tires.

The T-38 began life in 1954 as the N-156, Northrop Aircraft's 156th de-

The T-38 specializes in hair-raising vertical climbs (opposite). A formation of two is shepherded by a third (above), an exercise from a training syllabus that has changed little in 40 years.

OPPOSITE: NASM (SI NEG. #00079068)

BY PETER GARRISON ::: PHOTOGRAPHS BY CHAD SLATTERY


10845
TF-845
U.S. AIR FORCE

COURTESY HOWARD MORLAND

Howard Morland began his training in the dowdy Cessna T-37 but lusted for the curvaceous T-38. Eventually, he got the girl (right).

"You're low! You're low!" Chuck Thornton's voice in my headset is uncharacteristically brusque. We're approaching the long runway at Mojave, California, and I'm making the classic T-38 mistake of getting low and slow on the turn to final approach. After 20 minutes of rolls and 4-G turns, I can barely tell up from down. "My airplane," he says, and I feel the stick tugged from my grasp.

We've been at 14,000 feet in the airspace of Edwards Air Force Base. It's a beautiful desert spring day with tall cumulus buildups, and we've screeched around the columns of cloud in near-vertical banks and rolled inverted to skim their tops. I'm in the back seat, but I'm still so far out in front of the rest of the airplane that the only way I know it has wings is by peering in the rearview mirrors on the canopy bow. Being in the front seat must be like floating in the sky without any airplane at all.

A few flight characteristics stand out. One is the buffeting during maneuvering, the result of having the stabilizer low in the wake of the wing. The T-38's pre-stall buffet starts long before the actual stall, unpacking a rich vocabulary of rattles and rumbles that turn to rapid thuds as you get slow—"slow" being 160 mph or so. Another is the T-38's extreme smoothness and stability in cruise; hands off, you'd think it was on autopilot. There's the disorienting roll rate—I made only small inputs to the control stick for rolls because a maximum-performance roll is over practically as soon as it starts. There's also the not-too-shabby (at least to a civilian pilot like me) rate of climb, which I can't quantify because at 345 mph the vertical speed indicator simply pegged at its maximum indication, 6,000 feet per minute. And there was the long rollout after landing, using all 8,000 feet of a Van Nuys, California runway.

GEORGE HALL/CHECK-SIX

A handful of T-38s are registered to private owners.

Thornton Aircraft specializes in restoring T-38s and F-5s for civilian use. In 1985, the first T-38 the company restored took Grand Champion Warbird honors at the annual Oshkosh, Wisconsin fly-in, beating the usual formidable competition. Three and a half million bucks buys you just about the hottest airplane, short of the occasional MiG-25, that can be found out of uniform. It cruises at Mach 0.9 with a range of about 1,000 miles. No supercar on earth can match the impression you make taking your date to Vegas in a supersonic jet—but keep in mind that the total baggage allowance for the two of you is one cubic foot.

—Peter Garrison

Northrop chief engineer Welko Gasich vetoed wing-mounted engines: too much drag. The slender fuselage, with its Pinocchio nose, looked anorectic (far right).

NORTHROP GRUMMAN CORPORATION (NASM SI NEG. #00079061)

this model?" the Northrop people asked. "This isn't a model," replied the GE men. "This is the engine!"

Northrop's vice president for engineering, Edgar Schmued, saw in the tiny engines the possibility of reversing what he believed to be a pernicious trend toward ever larger, heavier, and costlier fighters. Engine weight was critical because, by a rule of thumb, each extra pound of engine weight would require six additional pounds of airframe. The J85—the brainchild of Ed Woll, one of GE's most gifted and influential engineers—was 22 inches in diameter and weighed less than 600 pounds, and in the form in which it would be used in the T-38, it developed 3,850 pounds of static thrust. Its thrust-to-weight ratio was superior to that of any other jet engine of its time. It sounded the death knell of the Fang project, from the ashes of which the N-156 arose.

In the initial stages of the N-156 project, Schmued favored a layout in which the engines were mounted on the wings, a location that he thought would make them easily accessible for maintenance. His chief engineer, Welko Gasich, disagreed: Wing-mounted engines produced excessive drag and aerodynamic disturbances. In Gasich's opinion, the engines had to be within the fuselage. Schmued resisted for a long time but eventually capitulated, and a buried-engine mockup was built. Designer Lee Begin laid down the mold lines—the outer shape of the airplane. It was a thrilling shape, different from that of any other airplane of its era. The wings were vestigial, the vertical fin huge. The immensely long nose, exotically contoured and tapering practically to a point, seemed so far from the wing as almost to belong to another airplane. The swellings and hollows of its mid and aft fuselage—scooped out at the waist in accordance with aeronautical engineer Richard Whitcomb's transonic area rule and expanding thereafter to envelop the engines—gave the fuselage a reclining-nude quality.

Northrop's competitor for the supersonic trainer contract was the F-100F, a two-seat variant of North American's F-100 Super Sabre. At the time, Northrop was not a supplier particularly in favor with the Air Force; North American was. Among Northrop's pitches was one that is so obvious today that it is hard to believe that it was new to procurement offices in 1956. It was the idea of "life cycle costs," which Gasich had brought with him from his previous employer, the RAND Corporation. While North American argued that the initial acquisition of the F-100F would be cheaper because the production line and the infrastructure for supporting the airframe and its engine were already in place, Northrop countered that in the long run, its new trainer would be cheaper because it used far less fuel and incurred lower maintenance costs. With two engines, it would also be safer; Northrop believed that it could bring the serious-mishap rate, then around 25 per 100,000 flight hours for the F-100, down to the range of seven to 10. The Air Force was persuaded. On June 15, 1956, a letter of intent was signed for what was now called the YT-38 Talon.

Several features changed during development. One was the arrangement of the vertical fin. A T-tail arrangement, like that of the F-104, with the stabilizer set atop the fin, had been considered and discarded early on, but the fin was originally designed with moderate sweep, like the wing. Flutter analysis indicated that the swept version might present difficulties. The crux of the matter was the stiffness of the aft fuselage, large portions of which had to be removable for engine access. In some jets, removing an engine required first removing the vertical fin, but it was a difficult design problem to make the fin easily detachable and yet suf-

NORTHROP GRUMMAN CORPORATION (NASM SI NEG. #00079050)

Excellent visibility helps T-38 pilots fly tight formations.

The T-38 is a looker from any angle, but an overhead view best shows off the wasp-waisted result of the application of the transonic area rule.

Weighing a mere fraction of the monster engines of the day, the General Electric J85 delivered one-fifth the thrust of the J57.

ficiently strong and stiff. Engineer Julius Villepique proposed what proved to be a key innovation. He fixed the fin to the keel structure that ran between the engines, and made the horizontal stabilizer, rather than the fin, the removable component, along with the "boat tail"—the entire aft shell of the fuselage surrounding the engines. The process of getting at the engines was extremely simple. Apart from the fasteners holding the fuselage shell together, the only parts that had to be disconnected were two push rods that connected the pilot's control stick to the valve controlling the horizontal stabilizer's hydraulic actuators. Hydraulic lines—there were only two—mated automatically, with internal check valves preventing loss of fluid.

The engines hung from rails on either side of the central keel. To avoid having to break and reconnect multiple hydraulic lines, designers mounted the hydraulic pump and other accessory drives on the fuselage, joined to the engine by a short driveshaft. Thanks to the rail support and the fuselage-mounted gearbox, once the boat tail had been detached, an engine could be removed and replaced in an hour.

Weight control was always a key factor in the trainer's design. The N-156 was intended to weigh 10,900 pounds full up—a fantastically low figure when you consider that the fighters of the time generally weighed between 30,000 and 45,000 pounds. Eventually it would grow by about a ton—but even then it was a model of weight control. Its systems were simple. The hydraulically powered flight controls lacked manual reversion, and if both engines failed, the pilots' only recourse was to eject. There was no fuel in the wings, no provision for external stores, and only basic systems for navigation and communication. Test pilot Lew Nelson took the prototype on its uneventful first flight on April 10, 1959.

"Science is done by single individuals, but engineering is done by a team, and I had a great team," recalls Welko Gasich today. In his voice you can hear his affection for the airplane and its creators, and for a halcyon period—"the height of the great 1950s and '60s screwdriver technology," one pilot called it—during which every choice his team made turned out to be the right one.

Despite its radical appearance, the T-38 is a gentle airplane in the air, straightforward in character, almost viceless, and thoroughly conventional in handling. An unmistakable buffet gives ample notice of an impending stall. For a long time the aircraft refused to spin at all. The Air Force's training command initially complained that the T-38 was too easy to fly, compared with the fighters for which it was supposed to be preparing new pilots. Gasich retorted that the Air Force ought to demand fighters that flew better—and that's what eventually happened. Today's fighters are so docile and forgiving that the T-38 is now, according to former instructor pilot Lewis Shaw, "the hardest airplane to fly in the Air Force's fleet."

It trains not only Air Force cadets, but test pilots as well. Says Northrop test pilot Roy Martin, "It replicates theory great; that's what makes it such a marvelous teaching tool." It flies just as textbooks say airplanes should. Lockheed Martin test pilot Dan Canin agrees with Martin up to a point, but adds that as far as test pilot training goes, the T-38's main defect is that it's too good an airplane—it doesn't give students enough faults to identify. Canin's favorite test pilot trainer was the de Havilland Beaver—"It had so many things wrong with it."

Second Lieutenant Alicia Evans, freshly graduated from T-38 school, hopes to be assigned to F-16s.

Since Lee Begin first shaped it, the T-38 has continually inspired affection. Lewis Shaw still calls it "the 36-24-36 blonde on the beach." Dan Canin raves: "I absolutely love the airplane. The T-38 and its siblings [F-5/F-20] are absolutely beautiful things...iconic, really...designed, it always seems to me, exactly as one would sculpt a fighter if he didn't have to worry about anything practical...like fuel, weapon systems, etc. As we go exclusively with stealth designs, which are inherently fat to incorporate weapons internally, I doubt we'll ever see fighters this good-looking again."

Like all objects of infatuation, however, the T-38 has become encrusted with legend and exaggeration. It's commonly said to roll at 720 degrees a second; the truth is 280 to 300, and in any case research suggests that anything above 220 merely serves to disorient the pilot. Another oft-repeated claim is that the T-38 climbs 33,000 feet a minute, even though the aircraft's time-to-climb record, set by Walt Daniel in 1962, is three minutes to 30,000 feet. According to Northrop's Roy Martin, a normal climb at military power—that is, maximum power without afterburner—is around 6,000 feet per minute.

Four decades have passed since the T-38 joined the Air Force. Its lines are no longer jaw-dropping; other airplanes have come to resemble it. It still clings to its old nickname "the white rocket," but today's pilots, comparing it with the F-15 and F-16, find the Talon underpowered. The thrust of present-day fighters is almost equal to their weight, and their maneuverability is superior to that of the T-38, which needs 10,000 feet to execute a loop and can't maintain both airspeed and altitude in a 5-G turn. (Nevertheless, T-38s were good enough for the Air Force precision aerobatic team, the Thunderbirds, which flew them from 1974 to 1982.) A-10 and B-1 pilots are kinder to it. Beth Makros, a former B-1 pilot now instructing at Vance Air Force Base in Oklahoma, was surprised to find that she felt right at home when she first transitioned from the tiny T-38 to the nearly half-million-pound B-1. "It handled similarly," she says. "Roll was similar, speeds are the same, it lands the same. They're surprisingly alike."

DEFENSE VISUAL INFORMATION CENTER

An F-15 Eagle flexes its Talons.

The T-38 does have faults. The J85 engines are temperamental at high altitude, and were prone to damage from ingested ice—the inlets are unheated—until the Air Force stopped flying Talons in icing conditions. The brakes, proportioned to fit into skinny wheels that are sized, in turn, to retract into the paper-thin wing, are barely adequate to stop it on a mile and a half of runway, even with a good deal of help from nose-high aerodynamic braking. Its original engine air intakes, optimized for supersonic performance, were too small to deliver sufficient takeoff thrust at high altitudes and summer temperatures.

The small, thin wing, only 25 feet in span, is responsible for the Talon's most troublesome characteristic: its lack of lift response at low speed. Dan Canin explains that in a significant portion of the low-speed flight regime, the so-called "back side of the power curve," the only way to gain speed is to lose altitude. "If you get slow with a big rate of descent near the runway, pulling the nose up will only result in the airplane hitting the ground in a more nose-up attitude—it won't stop the rate of descent at all." Landing the T-38 reliably requires precise speed and power control on final approach, and in particular not reducing power or raising the nose too early. The wing digs in like a shovel in mud, and once that happens, even the afterburners might not be able to pull it out.

That characteristic was tragically illustrated in 1966, when two NASA astronauts got into trouble at low speed while circling to land under a low overcast (NASA operates a large fleet of T-38s as trainers, space shuttle approach simulators, and astronaut runabouts). Pilot Elliot See kicked in the afterburners, but it was too late. The banking Talon hit the roof of a building and crashed into a courtyard, killing both pilots.

Nevertheless, the T-38 is, and always has been, one of the safest jets in the Air Force. Its serious mishap rate, originally projected to be 7 per 100,000 hours, has, for the past decade, hovered at or below 0.4 per 100,000 hours. Lewis Shaw attributes the safety record at least in part to the Air Force's having "gotten rid of the dark alleys" in the flight training syllabus: low-level single-engine work, formation flights with three solo pilots, and unstabilized approaches during simulated emergencies—flaps inoperative, one engine

out, and so forth. Also eliminated were rolling pull-ups from air combat training, which overstressed the wings. Now, he says, "the T-38 is more like a simulator than an airplane." Only 150 of the 1,187 T-38s built between 1961 and 1972 have been lost through attrition, with 45 deaths, while the fleet has logged 25 million hours in the air. Sixty percent of the losses occurred in the first 10 years, when the Air Force was still adjusting the syllabus to the new airplane; only four percent occurred in the last 10 years. Says Northrop historian Ron Gibb, "It's like having a squadron of 16 airplanes fly for 70 years before losing one of them."

Captain Beth Makros says the B-1 handles like a T-38.

T-38 wings were originally designed for 7.33-G loads and a fatigue life of 4,000 hours. The airplanes held up well until the Air Force began using them for dogfight training. "We were very aggressive with the jet," recalls David Rothenanger, who taught at Holloman Air Force Base in New Mexico from 1984 to 1987. "A dogfight by nature gets you that way. During one mission a very high roll rate was executed under almost maximum G, and *sproooooongggg*, bye-bye wingtip. It took almost full aileron to keep the wings level, but they were able to land the airplane." The failure occurred along a structural seam just outboard of the end of the aileron. The area was strengthened, and a new rule was added to the training syllabus: First roll to a desired heading, then level out and pull. Northrop produced new wings with thickened skins, improvements that the T-38 inherited from the parallel production of the heavier but structurally similar F-5 fighter, which Northrop had been selling in large numbers overseas, including, at one time, to the South Vietnam air force. A well-used T-38 today has 18,000 hours; many airplanes have had their wings replaced twice.

Remarkable for having gone through 2,000 hours of initial flight testing without modifications, the Talon has required few modifications in 44 years of active service. There have been only three versions: the original T-38A; an AT-38B, with wing and fuselage hard points, used for ordnance delivery training; and the latest, the T-38C.

The Air Force's entire fleet of more than 500 trainers will eventually be converted to the C model under a service life extension program called Pacer Classic. They will receive new, stronger wings, built of a high-strength alloy that will provide more fatigue resistance and an 8,000-hour life. Fatigue-prone parts of the cockpit structure will be replaced. A more bird-proof polycarbonate windscreen will replace the original, and the airplanes will receive propulsion mods, including larger engine air inlets, originally designed for NASA's fleet, to improve takeoff thrust and engine durability. Most important, under a $750 million contract that Northrop hoped to win but that went to Boeing instead, the original steam-gauge instrument panel is being replaced with a computer-based glass cockpit, complete with a head-up display. The T-38 is now expected to remain the Air Force's intermediate-level trainer until 2040. When the last student in the last T-38 takes to the air, he will be flying a design nearly 90 years old—almost as though today's pilots had trained in SPADs or Sopwith Camels.

On the wall of Howard Morland's Arlington, Virginia living room is a framed photograph of a pair of T-38s. He acquired it, along with a recurring dream of joyriding in a stolen T-38 that haunted him for years, when he graduated from flight training in 1967. A couple of years ago, at an airshow at nearby Andrews Air Force Base, a T-38 was on display, guarded by a young instructor pilot. "The airplane was at least a dozen years older than he was," Morland recounts. "I climbed the platform and looked down into the cockpit. It seemed like yesterday. I had a hard time shaking the idea that I was suddenly 40 years younger, with my life ahead of me."

Not so the T-38. At 40, half its life is still ahead.

NASM (SI NEG. #7A36690)

The Air Force Thunderbirds demo team hot-rodded in the T-38 for eight years.

COURTESY JOSEPH RISSO

THE FRENCH-RUSSIAN CONNECTION

FREE FRENCH PILOTS REMEMBER THEIR SERVICE IN THE SOVIET UNION.

BY Carl Posey

MUSÉE NORMANDIE-NIEMEN

The Niemen River, which rises near Minsk and meanders toward the Baltic, has long been the boundary armies cross to invade Russia—and cross again, in tattered retreat. In June 1812, Napoleon Bonaparte sent half a million soldiers along this route, Moscow bound. Six months later, 10,000 or so survivors stumbled out of Russia, harried by the Russian winter and mounted bands of Cossacks.

In the summer of 1941, Adolph Hitler's army followed Napoleon's trail into Russia. Three and a half years and hundreds of thousands of casualties later, they were back on the Niemen, fleeing into Poland and East Prussia. This time the harrying fire was from swarms of aircraft, including Yakovlev Yak-3 fighters flown by the Normandie-Niemen regiment of the Forces Aériennes Françaises Libres—the Free French Air Force. By then, everyone in Russia had heard of "the French Pilots"—a small band of volunteers who since early 1943 had been flying and dying in Russia's defense.

For many of these pilots, the road to the Eastern Front began as France prepared to surrender to Germany in June 1940. On June 18, just four days before it concluded armistice negotiations, France sent most of its pilots and airworthy warbirds to continue the fight against Hitler from colonial bases in North Africa. At the very least, officials in the falling government believed, the move would keep the aircraft out of Nazi hands.

The plan didn't quite work; the new Vichy government—named for the French city where the new, nominally sovereign French regime was set up to govern southern France and the Francophone northern rim of Africa—quickly absorbed the forces that had escaped to Algeria. The Curtiss 75A Hawks, Bloch 152s, and Moraine-Salnier MS-406s that had fought the Germans were turned against the British, as were the new Diwoitine D-520s that had proved effective against Germany's Bf-109E.

But even as those airplanes flew south, another French government was forming. Exiled Brigadier General Charles de Gaulle, in a broadcast from London, urged his compatriots to rally around the banner of France Libre. France's disaffected pilots responded. From the Etampes flight school south of Paris, Roland de la Poype and the others in his graduating class followed their commandant to England. Marcel Albert, Albert Durand, and Marcel Lefèvre—having flown about a dozen missions against the British—defected in their D-520s to Gibraltar and were placed in a Royal Air Force Spitfire squadron. Joseph Risso and two fellow pilots also made it to Gibraltar—in a four-place Caudron C-630 Simoun (Sandstorm) they "borrowed" in Algeria. Pierre Pouyade, who commanded a night-fighter unit in Cambodia, escaped to China in an old Potez 25 biplane and eventually found his way to London. One by one or group by group, French pilots peeled off for England, most of them in their early 20s, guided by a few old men nearing 30.

In the 1940s, Marcel Albert, Roland de la Poype, Didier Béguin, Marcel Lefèvre, and Joseph Risso were free, French, and ready to fight Germans.

Hitler thrust more than three million troops into the Soviet Union in June 1941, and de Gaulle saw an opportunity for his government-in-exile. He was inclined to send a division of the Free French army to the Russian front—a move he hoped would garner Moscow's formal recognition of his government. The commander of the just-assembled Forces Aériennes Françaises Libres, Brigadier General Martial Valin, persuaded him that a small air force unit would produce the desired effect, with fewer moving parts.

Word of what promised to be an excellent adventure went out to the FAFL units in Great Britain and North Africa. Fifteen pilots volunteered. They were led by Joseph Pouliquen, then the commander of a fighter

HARRY WHITVER

A.S. Yakovlev shortened the wing and trimmed weight from the Yak-1 to make the smallest, lightest fighter of World War II, and one of the most agile. From July 1944, Yak-3s dominated the skies in the East.

Cadolive, the French village where he was born. His friend Marcel Albert, who lives in Florida with an American wife, remembers the group's single-mindedness. The men were, Albert says, "just fighting the Germans." Not everyone approved. Some of de Gaulle's staffers detested the idea of French pilots flying for the Soviet Union, and the British—always wary of the French general's ambitions and loath to lose pilots then flying with the RAF—dragged their feet.

It was not until August that the volunteers began their long slog to the Eastern Front. They traveled to Lagos, Nigeria, by boat, then flew to Cairo. As they sailed south, the FAFL gave the unit a new moniker in line with General Valin's new practice of naming air wings after French provinces. "Alsace" had already gone to GC.1; "Ile de France" to GC.2. GC.3 would henceforth be known as Escadrille Normandie.

On November 10, two days after the Allies had begun the invasion of North Africa, the volunteers arrived in Lebanon, where they met de Gaulle and got their Soviet visas and some orientation training. Two days later, they flew to Baghdad aboard three U.S. C-47 transports. The group took a train to Basra, Iraq, and then was trucked to Ahvas, Iran, to catch another train for Tehran. By the time

group in North Africa. Captain Jean Tulasne, who flew for the RAF in Cairo, was second in command. Several interpreters, a doctor, and 40-odd technicians brought the unit's initial strength to 62.

The pilots did not volunteer out of a desire to defend Communism. "At our level," says Joseph Risso, "nothing was political. It was a decision of General de Gaulle himself." Risso lives today in

GC.3 pulled into that city, the Vichy airmen in North Africa had been told by their general that they too would fly as Free French, in British and U.S. aircraft.

On November 28, 1942, Escadrille Normandie boarded three Li.2s (Russian-built DC-3s) and finally crossed into the Soviet Union, landing at Baku. Then, as the descending winter permitted, the airplanes shuttled the men to a base at Ivanovna, 150 miles northeast of Moscow.

"It was 30, 40 below zero," says Albert. "We had no clothes to start with. We're out there with gabardine. They gave us coats and pants with fur and boots."

These were bleak days for the Soviet Union. By the time Escadrille Normandie arrived, Leningrad (now St. Petersburg) was in its second year of siege, Kharkov was lost, and the German fist was closing around the industrial region of the Donets River basin. Nazi Panzers had been looking down Moscow's throat for a year. Stalingrad was in its third terrible month of street fighting, and three million Russians had been taken prisoner.

The arrival of the French offered a glimmer of hope.

"The Russians liked us," Albert says. "There was one who told us we boosted their morale. They thought they were finished and then we are there. They said they thought we knew something they didn't."

At Ivanovna, the Normandie volunteers trained in the two-seat Yakovlev-7, then the Yak-1B fighter, which the pilots had chosen over U.S. and British alternatives. The -1B, like most Soviet fighters of the day, was built of steel tubing, light alloys, and wood. It was a powerful aircraft: fast, highly maneuverable, and heavily armed—"an airborne cannon and guns," says Risso.

The French took to it immediately. According to Albert, the Russian airplane cruised faster and climbed better than the Spitfire and the Bf-109. "As easy to fly as a kite," says Roland de la Poype, who lives in Paris today. "But if you dived over 500 miles an hour, you could lose the wings."

On March 19, the unit was deemed sufficiently trained to leave for the front. Three days later, GC.3 joined the Soviet 303rd Air Division at Polotniani-Zavod airfield, southwest of Moscow. On the 26th, Albert, de la Poype, and Risso flew the Normandie regiment's first sortie over Russia: They scrambled after a German reconnaissance airplane but made no contact. On April 5, flying cover for Petlyakov Pe-2 bombers, two pilots in the group, Albert Durand and Albert Prezisosi, shared first blood: a Focke-Wulf 190.

In the squadron log, Jean Tulasne, who in February had succeeded Poliquen as Normandie commander, wrote, "The squadron has arrived at the front during full thaw…the worst period of the Russian year…. The still-cold temperatures require a longer start of the engines (hot water and hot oil). The mechanics work about 14 hours per day. Moving the airplane on the ground between the stalls and the runway requires some 30-45 minutes and the help of all the squadron personnel. This for all the airplanes before and on their return from a mission…. The Soviet personnel have freed the only comfortable building on the base to billet the squadron. The food is excellent from every point of view: quantity and quality. Wine fairly often. Vodka for the pilots and mechanics each day there is a combat mission."

Morale was "excellent," according to Tulasne, but these were definitely new conditions for his men. "Fighting was entirely different," recalls Risso. "Yak aircraft had no bad-weather instruments. Furthermore, the radio equipment was far from the VHF used in England." And, Risso explains, "as the Soviets had no radar, the aerodromes were close to the frontline—about 20, 25 kilometers [12 to 15 miles]. Once, we did operate as close as five kilometers from the front." These "aerodromes" were spartan affairs. Albert remembers "no roads, no wire, no electric, no water—nothing."

Events seemed to confirm that Normandie's arrival had changed Russia's luck. Since the group had begun operations in November, what remained of Stalingrad had come back into Soviet hands, along with thousands of German prisoners. Russia—aided as always by a merciless winter—wore down the invaders, who were slowly driven back toward the Niemen.

> **One by one or group by group, French pilots peeled off for England, most of them in their early 20s, guided by a few old men nearing 30.**

Trailing the Soviet armor and infantry by only a few kilometers, the Normandie squadron moved from airfield to airfield: from Polotniani-Zavod in March, to Mosalsk in April, to Koziel in May, to Hationki in June. The billeting deteriorated to shelters made of branches and rope, and then the abandoned hovels of peasants. Pilots were lucky to get sausage; mere technicians got potatoes. The airplanes were kept in improvised revetments, disguised by branches and nets.

In May, German Generalfeldmarschall Wilhelm Keitel paid the Normandie squadron a grim compliment: He ordered

So grateful was Joseph Stalin for the pilots' service that he sent their Yaks home with them to France, where both were met with ceremony.

COURTESY MARCEL ALBERT

FROM THE FUNDS OF THE RGAKFD IN KRASNOGORSK

In 1943, the French pilots transitioned to Yak-9s, and their German foes were warned not to engage them at low altitude.

that all French pilots captured on the Russian front be executed. "We didn't know anything about Keitel's order until the Nuremberg trial in November 1946," recalls Risso. "What I can say is that 28 of ours were missing. Only three came [back] from prisoners' camps: Mahé, Bayssade, Feldzer."

By mid-summer 1943, as Russian aircraft regained control of the skies above the Eastern Front, it was clear to all concerned that the era of German air supremacy was over. But the westward trail from Moscow to the Niemen hadn't been kind to the Frenchmen. While Soviet forces fought their way toward Smolensk that April, two French pilots were killed in action. Another was lost in June. Squadron commander Tulasne and three more died in July.

"The Germans were scared of us," says Albert, but he adds that General Petit wasn't satisfied. " 'We want more victories at any cost!' " he snarls, imitating the general. "Bastard."

French pilots had begun trading their exhausted Yak-1s for Yak-9s, fighters that were optimized for high performance at low altitude—as many a Luftwaffe pilot discovered while trying to turn with the Russian fighter near the ground. The Yak-9 had a teardrop canopy for better visibility and wings strong enough to hold internal fuel cells. Some -9s had a small bomb compartment behind the pilot. Some were tank killers, with a big 37-mm cannon replacing the 20-mm gun in the nose, and the cockpit shifted a half-meter aft to accommodate the breech.

In July, the squadron's mechanics returned to North Africa and were replaced by Soviets, who were familiar with the new and more powerful Russian airplane. In August, the Normandie group moved to a field in Gorodichina. "The mechanics rode in the back seat of the Yak-9," recorded Tulasne's successor, Colonel Pierre Pouyade, in the squadron log. "The pilots were received in a very amicable fashion by the Russian officers of the regiment, and were profoundly touched by their attention. At the entrance to the rooms were streamers bearing the inscription, TO THE BRAVE SONS OF THE FRENCH PEOPLE, WHO WITH OUR VALIANT ALLIES, WILL VANQUISH THE EXECRABLE ENEMY. In the evening, good cheer, vodka. Cinema was an agreeable surprise."

"The Germans were scared of us," says Albert, but General Petit wasn't satisfied. "We want more victories at any cost!" he snarls, imitating the general. "Bastard."

VON HARDESTY/NASM

But all was not well. General Petit wrote de Gaulle that life on the Russian front had become very hard, especially as the unit developed "a sense of being abandoned." To make matters worse, the men were not being paid. The acerbic Pouyade wrote: "The greetings of Soviet officials replace the money of the French command."

According to Albert, the pilots came close to getting paid only once. "Stalin decided to pay our salaries," he says. "We were not getting any money—30-some months in Russia without pay. Stalin said, 'Okay, I'm

By war's end, the French pilots had scored 129 victories against the Luftwaffe.

going to pay these guys in dollars.' He had a big sack of money. We were [to get] $750—at that time a pile of dough. But [General Petit] said, 'We are not fighting for money.' That one—he was not fighting at all."

Quips Roland de la Poype, "Pay? We never had a problem. We never got anything. *Rien*."

In September, Normandie divided into two squadrons: The first, Rouen, was led by Marcel Albert, with Roland de la Poype on his wing. The second, Le Havre, was commanded by Didier Béguin, with Risso on his wing. That month, Albert Durand—with nine individual and two shared kills—vanished in action on the road toward Minsk. Another pilot went down in October. By then, says Albert, "we were about finished." Normandie's handful of survivors fell back to Toula, south of Moscow, to train the new pilots shuttling in from Free French forces in North Africa. Two more squadrons were formed: Cherbourg, commanded by Marcel Lefèvre, and Caen, led by Louis Delfino.

The second campaign opened in May 1944 with the Normandie regiment back at the front, at a rough field near Doubrovka. There, the commandant's diary continued its refrain of loss. Henri Foucaud was killed in late April. In May, returning from a mission over Vitebsk, Marcel Lefèvre's Yak-9 hemorrhaged fuel and burst into flames a few feet off the ground; he died in a Moscow hospital a month later. (He survives in spirit as a host figure at the Normandie regiment museum in his home town, Les Andelys.) In July, Maurice de Seynes' Yak filled with gas fumes, but he refused to bail out because his Russian mechanic, seated in cramped space behind him, had no parachute. Both men died after several aborted approaches to the field at Mikountani. Camille-Jean Bertrand was killed in August, as the offensive near Kaunas pushed the invaders back across the Niemen River.

The regiment was by then transitioning to the Yakovlev Yak-3. "It is an excellent machine," an enthusiastic Pouyade wrote, "superior to the FW 190 in all the dimensions. In everyone's opinion, it is probably the best fighter plane of the armies of the world. It is one of the fastest and, in every case, the lighter and more maneuverable airplane, the best climber of the world. Visibility is perfect."

MUSÉE NORMANDIE-NIEMEN

As 1944 wore on, however, the pace of combat slackened, along with the flow of news and supplies. The war was clearly winding down. De Gaulle had returned to liberated Paris in August; France was free. Why were French pilots still in Russia?

"Because of the persistent lack of fuel, of airplanes, of flight operations," a dejected Pouyade wrote his general, "the morale of all the pilots is very bad. Our inactivity menaces [the] aeronautical prestige which Normandie has gained thus far. In consequence, I propose the withdrawal of operations, with the return of the regiment to France where it can be sent immediately to a sector where it shall surely find work. If [this] is unacceptable I

CARL POSEY

CAMERON DAVIDSON

Marcel Albert (above) was the leading French ace, with 22 kills. Today in his Florida home, he remembers his war service. Squadron mate Roland de la Poype (inset) lives in a Paris apartment.

have the honor of asking that I be relieved of my command." Pouyade departed on November 11. Delfino assumed his role.

Less than a week later, there was bigger news. "Yesterday we heard, by radio that General de Gaulle has been invited to come to Moscow," Delfino wrote on November 17. "All hope to see him come to the Regiment." Just days after that, Albert and de la Poype were named Heroes of the Soviet Union.

For its role in ejecting the German invaders, the unit got a new designation from Premier Joseph Stalin: Normandie-Niemen, the second name after the historic river. In December, the regiment traveled by special train to Moscow to meet the visiting de Gaulle, and the men were awarded French and Soviet medals all around.

The air wing's war wore on, though, along with the hard winter. "The snow still falls and we pass a solitary Christmas in our rooms," noted Delfino. "Now and then a bottle of cognac appears." Of the regiment's original pilots—only six had survived—none fought in the short campaign of spring 1945. "We were sent to France to rest according to General de Gaulle's decision," says Risso. Albert got typhus and nearly died.

// Marcel Albert remembers meeting French POWs late in the war who derided the pilots as Communists. After the war, says de la Poype's wife, de Gaulle "wiped away the problem."

FROM THE FUNDS OF THE RGAKFD IN KRASNOGORSK (2)

The Normandie-Niemen squadron was a highly decorated one: The French Minister of Aviation adds a ribbon to the squadron's flag in a 1945 ceremony in Paris after …

Two weeks after Germany's May 9 surrender, five Dakotas flew into Insterbourn to take the regiment back to Moscow, where they paid their respects to comrades buried in the foreigners' cemetery. That night, Jacques André and Marcel Lefèvre were posthumously named Heroes of the Soviet Union. Party followed party. "New reception at the French embassy," wrote Delfino. "Lots of music, lots of people, little to drink."

The idea had been for the regiment to return the way it had come: by way of the Middle East. But on June 9, General Petit sent a telegram relaying a message from Stalin: "As he considers that 'Normandie-Niemen' has fought very well on the Soviet front, it does not seem just to disarm it and remove its materiel. It is proposed that the pilots of Normandie-Niemen return to France with their combat aircraft." Delfino recorded the pilots' response: "A joyous reaction."

At six that evening on June 15, 40 Yak-3s lifted off for Prague. Five days later, after several stops and parties and a few losses, 37 touched down at Le Bourget airport in Paris.

The Normandie-Niemen regiment left quite a record in its wake: 5,240 missions flown, 273 confirmed kills, 37 probable, and 45 enemy aircraft sorely damaged. Among the unit's 39 aces, Marcel Albert led with 22 confirmed kills, one probable, and two more in other theaters. Roland de la Poype ranked second, with 16, two probables, and two aircraft damaged. Joseph Risso finished at ninth place: 11 kills, four probables. But the regiment's victories had not come cheap: Of the 96 pilots who

…General Charles de Gaulle presented medals to the pilots in Moscow.

went to Russia, 46 did not return.

Only about a dozen of the Normandie-Niemen pilots who served in Russia are alive today, and only three of the first group survive—the same trio that shared the first Normandie sortie. In old photographs, one sees three very different young men—Albert, a former Renault mechanic, rough and ready, impatient of authority; the aristocratic de la Poype, languid in his boots and riding britches; Risso, the reflective southerner, always working on his pipe.

VON HARDESTY/NASM

None of the 4,848 Yak-3s built through 1946 is flyable today, but warbird collector Christophe Jacquard (below, center) flies a new reproduction. Former Yak pilots (left to right) Georges Mazurel, Joseph Risso, Pierre Lorillon, and Edmond Gille helped celebrate the Yak's 2001 arrival.

Marcel Albert crashed a D-520 during an air show in Paris; he flew very little after that. He met his wife, Freda, while he was the French air attaché to Prague, and moved to the United States in 1947. After working in the restaurant business, the couple settled in the Florida panhandle, in a roomy bungalow rich with Normandie-Niemen memorabilia.

Roland de la Poype stayed with aviation but made his fortune as an inventor of disposable plastic containers, among many other things. He and his artist wife Marie-Nöelle live in a lavish Paris apartment a half-mile west of the Trocadero. They have participated in a variety of enterprises, including the Marineland Antibes theme park, where they have bred orcas and dolphins. "I found fun everywhere," says de la Poype. "I've been born under a lucky star."

Risso rose through the ranks of the French air force and retired as a brigadier general in 1971, returning to Cadolive.

One wonders, when talking to them, how they were treated once the glow of World War II chilled into the cold war, and the Soviets became the enemy. Were the Normandie-Niemen *anciens* made to pay for their Russian adventure?

Albert barely understands the question. He views those old days without a cold war filter. Russian gratitude still touches him, and his memories of Soviet comrades still bring a smile. But he also remembers meeting French POWs late in the war who derided the pilots as Communists.

De la Poype says little on the subject, but his wife acknowledges that after the war, "there was a definite tendency to see the Normandie-Niemen pilots as Communists. De Gaulle kept this from happening—it needed somebody that powerful," she says. "He wiped away the problem."

During a long military career, Risso has viewed the Soviet Union through both lenses, but never sensed adverse vibrations from either side. "One should remember," he says, "that Normandie-Niemen still carries on exchanges with the Russian squadron." For example, pilots from the modern Normandie-Niemen unit's successor squadron traveled to Russia in June 2001 to commemorate the 60th anniversary of the Great Patriotic War. During the event, the French pilots flew Russian Su-27s, and the Russians, French Mirages. And as of 1989, Risso says, 144 schools in the Soviet Union still bore the name Normandie-Niemen.

XAVIER MEAL

Although the three old friends meet infrequently now, each is intensely and affectionately interested in how the others are doing. *You talked to Albert? Is he well? Is he fat? How did you find de la Poype? Tell Risso I send my love.* As you listen, the years fall away, and *voilà*! —there are those young men in the Yakovlevs. The French Pilots.

HANS GROENHOFF PHOTOGRAPHIC COLLECTION (HGC-838-B), NASM

HANS GROENHOFF PHOTOGRAPHIC COLLECTION (HGC-1124), NASM

NASM (SI NEG. #7A49058)

Hans Groenhoff wasn't the pilot in the family. That was his brother Günther, who set a slew of international soaring records in the years following World War I. But Hans, a lawyer by training who came to the United States from Germany the same year Lindbergh landed in Paris, may have made the bigger mark on aviation. As a writer and photographer for magazines like *Esquire*, Hans Groenhoff documented the airshow scene in his adopted country during the two decades leading up to World War II, and in the process turned in some of the most elegant and memorable shots of airplanes ever taken.

Groenhoff (upper right) had an eye for the odd juxtaposition, whether it was a woman and dog with a Fairchild 24W (opposite), a Piper Cub with a Louisiana cavalry unit in 1941 (above), or another Cub perched improbably on the massive wing of a Martin Mars flying boat (lower right).

Groenhoff died in 1985. Looking back on his 50-plus-year career, he once wrote, "From gliders…to Phantoms, I chased them all."

HANS GROENHOFF PHOTOGRAPHIC COLLECTION (HGC-1073), NASM

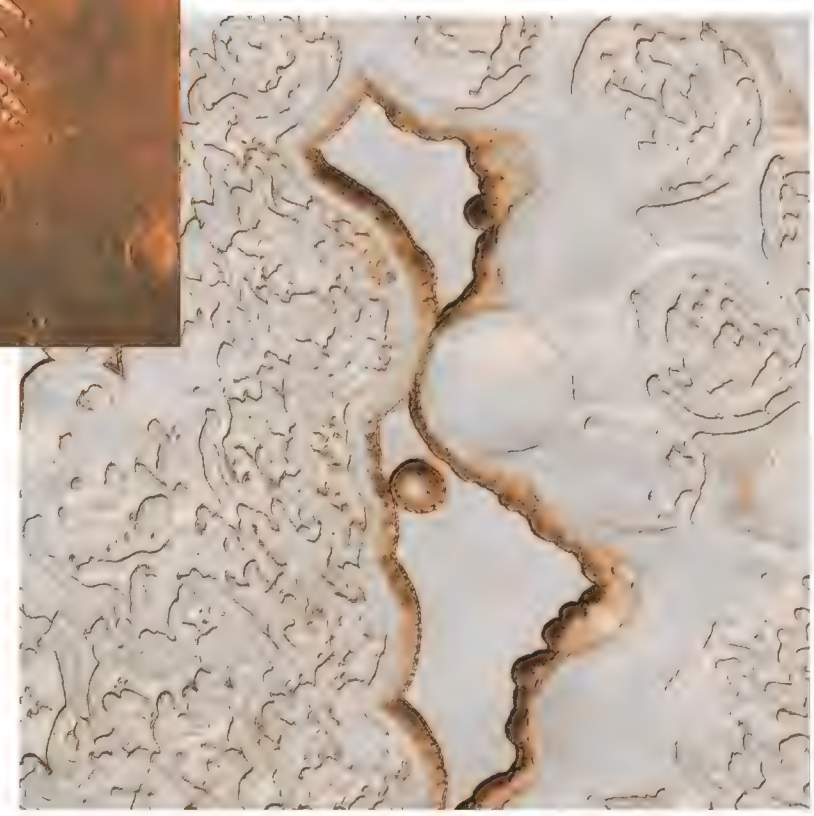
Mars Madness

Dying Planet: Mars in Science and the Imagination
by Robert Markley. Duke University Press, 2005. 40 pp., $24.95.

Visions of Mars
by Olivier de Goursac. Abrams, 2005. 160 pp., $29.95.

War of the Worlds
by H.G. Wells. 1898. Electronic text at http://www.fourmilab.ch/etexts/www/warworlds/warw.html

DR. PHILIP CHRISTENSEN



DR. MICHAEL MALIN

Wind-eroded, compacted volcanic ash (above) leaves a Yeti-like imprint. Dry ice mesa (right) has 33 feet of icy, dusty slopes.

What is it about Mars? Having spent billions already to launch 39 spacecraft (including this summer's Mars Reconnaissance Orbiter) to the Red Planet—more than twice the number of probes sent to all other planets combined—why do we keep going back? What are we looking for?

Maybe ourselves. That's one conclusion to be drawn from Robert Markley's fascinating *Dying Planet*, a scholarly exegesis on the cultural, political, and scientific meanings of the fourth planet from the sun. Markley, a University of Illinois English professor whose interests range from 17th century England to virtual reality, follows in the footsteps of other historians of planetary science, like William Sheehan, in his richly detailed account of how scientific and literary views of Mars have changed over time.

Mars had a privileged status in the human imagination even before Percival Lowell saw canals engineered by dead civilizations or Wernher von Braun started designing rockets to take us there. In the late 19th century, Mars was "the favored site for thought experiments" where Christian or socialist utopias could bloom at a safe remove from Earth. Markley takes the story into the Space Age, and ponders more recent scientifically informed views of the planet, including the recurring argument—still going on today—over whether life exists there, and how we would recognize it if it did.

Olivier de Goursac's *Visions of Mars* reminds us that stark, dead geology can be quite beautiful. Just as artist Michael Light did in his critically acclaimed volume of Apollo photography, *Full Moon*, de Goursac, a French science writer and expert in space imagery, lets the photos speak for themselves. Filled with dozens of new pictures from the recent NASA rovers and European orbiter, *Visions of Mars* makes a fair case that the planet deserves all the special attention it has received, if only for aesthetic reasons. But does it?

NASA often trumpets the search for life as the ultimate rationale behind its Mars program. But we're already pretty sure there is no life on Mars, or none of real significance. Maybe the billions spent exploring Mars with robots, or gearing up—as NASA is beginning to in 2005—to send astronauts there, would be better

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www.slooh.com; *starting at $49.95 per year for unlimited group missions plus 15 minutes of solo time; deluxe membership for more solo time is $99.95 per year; additional time and monthly memberships available. Required system: 56K modem, Flash 7.*

"We deliver what people expect to get when they buy a telescope," says Mike Paolucci. The company he co-founded is a Web-based telescope-sharing service called Slooh (get it? you "slew" a telescope) that allows anyone who doesn't mind sharing with others (or paying premium to solo) to download the view of the night sky, captured by optical telescopes in the Canary Islands. There, atop a nearly 8,000-foot mountain, the weather is clear a reported 80 percent of the time, and the time is five hours ahead of the U.S. east coast. No more waiting around for it to get dark—on the Canaries, it already *is* dark. Objects viewed include the moon, Saturn, Mars, and more distant bodies. Control panels appear on your computer's browser display for selection of viewing modes, and you can select from a database of stored images, which includes globular clusters and the Crab Nebula, or explore on your own. Groups are already at work hunting comets, and in the future, amateurs could get grants of time to explore the sky.

—George C. Larson

Tempered Steel: The Three Wars of Triple Air Force Cross Winner Jim Kasler

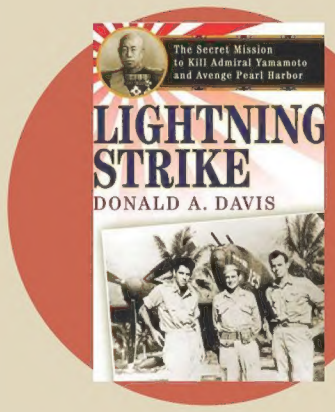
by Perry D. Luckett and Charles L. Byler. Potomac Books, 2005. 271 pp., $27.95.

James Helms Kasler is a member of that star-crossed group of professional warriors who were just young enough during the closing years of World War II—18, in Kasler's case—to serve again in Korea and Vietnam.

Kasler, an Air Force fighter-bomber pilot was an unusual phenomenon—an enlisted man who became an officer (a colonel when he retired in 1975)—so he knew the military from bottom to top. At the end of the first of his three combat tours, he took the first official post-bombing close-up photos of Hiroshima and Nagasaki from the side door of a B-29. Kasler went on to become an F-86 ace in Korea, then flew the F-100 Super Sabre, and ultimately became an F-105 specialist.

You won't enjoy this book if you disagreed with the Vietnam War. Although Kasler accepts the need for differing opinions—he enjoys pointing out it's one of the freedoms for which he fought—he considers protest and activism to be at best cowardly and at worst treasonous. This is a hagiography. At times it left me in tears, but ultimately it left me wanting a less sanitized account of an obviously remarkable man.

—Stephan Wilkinson



Lightning Strike: The Secret Mission to Kill Admiral Yamamoto and Avenge Pearl Harbor

by Donald A. Davis. St. Martin's Press, 2005. 385 pp., $25.95.

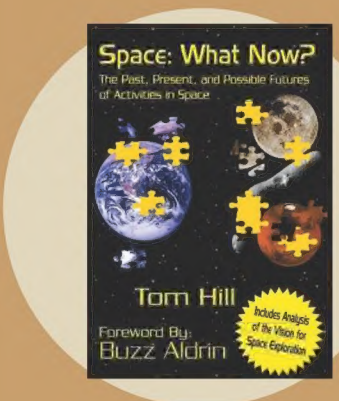
When air ace Major John Mitchell led 16 P-38 Lightnings on the longest combat mission yet flown (420 miles, one way) on April 18, 1943, his target was the Japanese admiral considered the architect of the Pearl Harbor attack.

Mitchell's pilots used secrets gained by breaking Japanese codes to intercept and shoot down Yamamoto Isoroku, the Harvard-educated naval genius of Japan's war effort. After the admiral's death, Japan never again won a major battle in the Pacific war.

No band of brothers ever worked together better than the Americans who planned and flew the mission to kill Yamamoto, yet after the war, veterans fell to bickering over which P-38 pilot actually pulled the trigger.

Davis provides exhaustive biographical details of Yamamoto and Mitchell. And he mercifully spares us the canard about Yamamoto calling pre-war America a "sleeping giant." The admiral never uttered those words. This is a general history with a purpose much broader than answering the oft-asked "Who killed Yamamoto?" Still, after reading *Lightning Strike*, you won't have any doubt.

—Robert F. Dorr



Space: What Now? The Past, Present, and Possible Futures of Activities in Space

by Tom Hill. PublishAmerica, 2005, 310 pp., $24.95.

"We are at a critical time, where humankind can choose between two futures," writes Tom Hill, winding up for the pitch. "In one future, we move beyond the world that gave us life and nurtured our minds.... In the other, we sit in place...turn our back on potential lands beyond and resign ourselves to the fact that there are no other places to go.... The methods for making such journeys are important, but the decision to go itself is critical. I say we must move on."

Hill's refreshing wit and humor on a topic that usually draws humorless zealots is part of what makes this book so user-friendly. Hill, a project engineer at the Aerospace Corporation, has fashioned a breezy account of the space program that provides history up front, a technical section at the end, and careful, sometimes self-effacing explanations throughout. He also presents a well-balanced call for various government-private sector alliances in space, and addresses President Bush's "space vision." Hill is careful to not only specify both the advantages and disadvantages for just about every topic he covers, but to clearly state his biases as well.

—William E. Burrows

applied to the search for Earth-like planets around other stars. Find us some real aliens, dammit.

That is, if we really do want contact. Sometimes you have to be careful what you wish for. H.G. Wells' *War of the Worlds*, which Markley calls "the first great novel of interplanetary invasion," is on the big screen again this summer, reinterpreted by Steven Spielberg as an American family's saga in the age of ultimate terrorism.

Like us, Spielberg has never been able to decide just how friendly the aliens will be when we finally make contact. The answer likely has to do our current sense of optimism or insecurity, which varies from generation to generation. Will it be ET and the doe-eyed Greys from *Close Encounters*, or the cold biological killers Wells envisioned in 1898? It's a drama that's been playing on Mars for centuries, as Markley well knows.

—Tony Reichhardt

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CREDITS

Fast, Cheap, and Out of Control. Peter W. Merlin, a founding member of the X-Hunters Aerospace Archeology Team, is a contract archivist and historian at NASA's Dryden Flight Research Center in California.

The Case of the Spurious Transmissions. Tom Huntington, a former managing editor of *Air & Space/Smithsonian*, now works as a freelance writer from his home in Pennsylvania.

The Rainmakers. Douglas Gantenbein is the Seattle correspondent for *The Economist* and the author of *A Season of Fire: Four Months on the Firelines of America's Forests* (Penguin, 2003).

Spaceman. Documentary producer and writer Geoffrey Little is currently working on a book about the 12 men who walked on the moon and their lives after Apollo.

Planes, Trains, and Waterfalls. Sam Goldberg is a freelance writer currently exploring the culinary world of Christchurch, New Zealand.

With his right elbow on the control wheel of his Cessna 172 and with the left window open, Baron Wolman has photographed the world below from California to Africa.

The Short, Happy Life of the Prop-fan. Bill Sweetman used to write about prop-fans back when some people thought they were a good idea. He even took a press flight on the McDonnell Douglas UDF demonstrator. He is now a writer specializing in aerospace and military.

When Stars Collide. Trudy E. Bell is the managing editor for *Journal of the Antique Telescope Society*. She is writing a book on three centuries of astronomical expeditions.

Further reading: *Einstein's Unfinished Symphony: Listening to the Sounds of Space-Time*, Marcia Bartusiak, National Academies Press, 2000.

Restoration: A Bell That Didn't Ring. William E. Burrows says he has also been restored.

White Rocket. Peter Garrison is a freelance writer, airplane designer, software engineer, and child chauffeur. He lives in Los Angeles.

The French-Russian Connection. Longtime contributor Carl Posey is the author of the novel *Red Man's Will* (Xlibris, 2003).

CALENDAR

August 1–September 18
American Society of Aviation Artists Exhibition. Patuxent River Naval Air Museum, Lexington Park, MD, (301) 863-7418, *www.paxmuseum.com*.

August 6 & 7
Thunder Over Michigan Bomber Roundup. Six B-17s, two B-24s, four B-25s, and one B-29 will commemorate the 60th anniversary of the end of World War II. Willow Run Airport, Ypsilanti, MI, (734) 483-4030, *www.yankeeairmuseum.org*.

August 13 & 14
B-25 Family Day. See a B-25 Mitchell bomber on the ground and in the air. Warhawk Air Museum, Nampa, ID, (208) 465-6446.

August 18–21
Ride on a Boeing B-17 bomber. Cincinnati Municipal-Lunken Airport, OH, (800) 359-6217, *www.b17.org*.

September 3
Victory Over Japan Seminar, featuring a flight demonstration by a World War II-era Douglas SBD-5 Dauntless. Planes of Fame Museum, World War II Cal-Aero Field, Chino, CA, (909) 597-3722.

September 7–10
Reunion: 388th Bomb Group Association. Albuquerque Marriott, NM, (253) 838-9291.

September 8–11
Reunion: Sampson Air Force Base Veterans. Sampson State Park, Seneca Lake, Romulus, NY, (716) 633-1119.

September 21–24
Beijing Aviation Expo. Beijing, China, 852 25117427, *www.beijingaviation.com*.

September 29–October 2
Reunion: 459th Bombardment Group, 15th Air Force (World War II). Holiday Inn, Shreveport, LA, (318) 222-7717.

September 30–October 2
California International Airshow. U.S. Air Force Thunderbirds, Shockwave jet truck, Robosaurus, and Masters of Disaster. Salinas Municipal Airport, CA, (888) 845-SHOW, *www.salinasairshow.com*.

Dawn Patrol Rendezvous World War I Fly-In. Featuring flyovers by original World War I aircraft and reproductions. National Museum of the U.S. Air Force, Wright-Patterson Air Force Base, OH, (937) 255-8046, ext. 492.

FORECAST

In the Wings. . .

CAMERON DAVIDSON

Eight Stearman Kaydet trainers call Van Sant Airport home.

The People and Planes of Van Sant

Our tour of the country's small airports takes us to Bucks County, Pennsylvania, where a visitor can get a check ride in a Stearman or simply watch the parade of vintage airplanes passing through on any autumn weekend.

Minutiae

Having trouble envisioning an aircraft with the name Wee Bee? No problem. We've got photos of the itty bittiest airplanes that ever flew.

The Worst Job in the German Navy

What it was like for World War I zeppelin crews, oxygen-deprived in the bitter cold at 18,000 feet and flying into the searchlights over London.

Titanic News from Titan

The European Space Agency's Huygens probe descended to the surface of Saturn's moon last January. What did it see to make scientists call Titan "extraordinarily Earth-like"?

The Nuclear Option

Strategic bomber crews remember the strain of the Cuban Missile Crisis and what it really meant to be ready.

ON THE WEB SITE

www.airspacemag.com

T-38 fans will learn just how fitting the nickname "White Rocket" is (see p. 58) by reading an excerpt from *Sky Walking*, a forthcoming book by astronaut Thomas D. Jones (Smithsonian-Harper, expected in early 2006). Another excerpt on the Web this month: From Marcia Bartusiak's *Einstein's Unfinished Symphony* (The National Academies Press, 2000), the story of the discovery of a distinctive type of paired pulsars, which provided early indirect evidence of gravitational waves ("When Stars Collide," p. 50). And we present details of the Convair 440's augmented exhaust and heat-capture systems ("Planes, Trains, and Waterfalls," p. 34), with an overview of the airplane's lesser-known competitor: the Martin 404.

BRIAN NICKLAS

Astro perk: NASA's shuttle pilots and mission specialists train in T-38s.

Third Type's a Charm

The National Aeronautic Association estimates that there are no more than a few dozen pilots who hold aviation records in multiple aircraft types. Adventurer Steve Fossett, Voyager pilot Dick Rutan, SpaceShipOne pilot Mike Melvill, shuttle commander Hoot Gibson, and speed-record setter Jackie Cochran, are among the best known.

Dave Riggs, a movie trailer producer in Hollywood, California, recently added his relatively unknown name to that list when he, along with copilot Jeff Acord, set his third aviation record in March. Riggs is now the only pilot to hold records for piston-engine aircraft, helicopters, and jet aircraft.

DAVID RIGGS

Despite 25 years of flying, Dave Riggs said flying the jet was like starting over.

Riggs and Acord flew Riggs' L-39C, a Czech-built military jet, round trip between Los Angeles and Phoenix, setting a record on both legs. He established unlimited and class records for speed over a recognized course, averaging 561 mph to Phoenix and 365 mph on the return.

While Riggs' recent record is an accomplishment in itself, becoming proficient enough to set records in three completely different aircraft is even more impressive.

"Flying those different types of aircraft is like the difference between driving a golf cart and a Ferrari," Riggs says. "They both have four wheels, but that's where the similarities end."

Riggs, 43, has been flying since he was 16 years old, and says being in the air has become a way of life. A little over two years ago he decided to buy a jet, and found he had to learn to fly all over again.

"I had been flying for 25 years, and I felt like a rookie again," Riggs says. "It took a hundred hours before I really felt comfortable in it."

Eventually, he and Acord, whom Riggs had met while setting his first three aviation records in 2003, decided to go after a record in Riggs' jet. Part of the allure was the fact that no one held the combination of records Riggs was after.

Despite a lot of planning—they started preparing for the attempt in August 2004—the record flight still didn't go exactly as forecast. They had planned to land in Phoenix with the minimum amount of fuel left in the tanks, as is required by the Fédération Aéronautique Intérnational. But during the flight they discovered that fuel in the auxiliary tank was not transferring to the main tanks. Riggs and Acord, an air traffic controller who also holds a piston engine speed record, crunched the numbers and hoped favorable winds would allow them to finish the record with legal reserves.

"We decided it wasn't going to look too good at Jeff's day job if we ran out of gas," Riggs says. Luckily, the winds held up and they landed with ample reserves, flying the 374 miles between L.A. and Phoenix in just under 40 minutes.

"I knew it was unique to have records in rotorcraft, jets, and piston engines," Riggs says. "Everybody tries to set a speed record for their own reasons. For me, flight is about enjoying it, and a record is about planning and precision, and to get a speed record you have to do everything right. And that's fun to try."

—Dustin Gouker

LOGBOOK

Mackay Trophy Winners

Two United States Air Force HH-60G Pavehawk helicopter crews, known as Jolly 11 and Jolly 12, won the prestigious Mackay Trophy for their outstanding service during Operation Iraqi Freedom in 2004.

The Mackay Trophy is administered jointly by the United States Air Force and the National Aeronautic Association. It is awarded annually for the most meritorious flight of the year by Air Force personnel or organizations.

On April 16, 2004, during a rescue operation near Kharbut, Iraq, Jolly 11 and 12 were sent to the site of a U.S. Army CH-47 Chinook helicopter that had crashed in a sandstorm in near-zero visibility. The conditions rendered the crews' infrared and night-vision goggles ineffective, making navigation extremely difficult and the rescue attempt much more dangerous. All five survivors of the crash were rescued, but the crews still had to deal with attacks by multiple surface-to-air missiles. The Jolly 11 and 12 pilots used evasive maneuvers to avoid the missiles, and the crews were able to evacuate the combat zone unharmed. The citation that accompanies the award reads: "Their gallantry and devotion to duty reflect great credit upon themselves and the United States Air Force." Jolly 11 and 12 are based at Moody Air Force Base in Georgia and are a part of the 41st and 38th Rescue Squadrons, respectively.

The Mackay Trophy was first presented by Clarence Mackay in 1912 and deeded to the National Aeronautic Association; the original trophy is on display at the National Air and Space Museum in Washington, D.C.

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